Approach and Main Entrance of New Agricultural Building, University of Wisconsin.

TWENTY-FIRST ANNUAL REPORT

OF THE

Agricultural Experiment Station

OF THE

UNIVERSITY OF WISCONSIN

For the year ending June 30, 1904.

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☞ **The Bulletins and Annual Reports of this Station are sent free to all residents of the State upon Request.**

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Dairy Building and Joint Horticulture-Physics Building, west end of Observatory Hill, near Agricultural Hall, Horticultural Grounds and Experiment Farm.

Telephone to Station Offices, Dairy Building and Farm Office.

LETTER OF TRANSMITTAL.

ASHLAND, WIS., November 1, 1904.

To His Excellency, ROBERT M. LA FOLLETTE,

Governor of Wisconsin:

I have the honor to transmit to you herewith, in accordance with law, the Twenty-first Annual Report of the Agricultural Experiment Station of the University of Wisconsin.

Respectfully,

GEO. F. MERRILL,

President of the Board of Regents.

Group of Agricultural Buildings, University of Wisconsin, from the west; Central Heating Plant in the foreground at the left, in front of the Horticulture-Physics Building with greenhouses. The central building in view is Hiram Smith Hall, the Dairy Build'ng, and at the right of this building appears the new Agricultural Building. In the distance at the extreme right, University Hall. The farm residences, barns and stock-judging buildings are grouped about sixty rods west of the buildings here shown.

REPORT OF THE DIRECTOR.

The twenty-first annual report of the Experiment Station covers the fiscal year ending June 30, 1904. The subject matter embraces various investigations conducted in the different departments during the past year and summarizes in some instances efforts covering a number of years.

The preparation of the grounds immediately about the new Agricultural building was completed early in the spring and much planting of shrubs and seeding of lawns undertaken. Cement sidewalks, six feet in width, have been constructed about the building, also a macadam drive approach to the east portico and a driveway up Observatory hill in the rear of the building. There yet remains as an immediate necessity the completion of a macadam driveway connecting Linden drive with the Lakeshore drive, passing in front of the Dairy building and the Dean's house. From this, in turn, a driveway should be made leading in front of the Horticultural building and upward along the north slope of Observatory Hill, connecting with the Observatory drive. When this improvement is made there will yet be need of sidewalks and the planting of trees along such drives. This work may be undertaken the present fall. It is contemplated to at once begin the extension of the farm lawn eastward, uniting it with that surrounding the new Agricultural building. When this is done there will be a long stretch of most attractive green sward dotted with shrubs and vines, the whole forming an effective prospect skirting Linden drive between the Central Agricultural building and the group of farm buildings.

Changes in Station Staff.—Mr. F. J. Wells, Assistant Professor of Agricultural Physics and Assistant Physicist of the

Station, died, after a brief illness, March 1, 1904. His untimely death was a great shock to his friends and his going a loss to the cause of agricultural education.

Mr. Wells was succeeded April 1, 1904, by Mr. Charles William Stoddart, a graduate of Columbia College. His title is Instructor in Agricultural Physics in the College and Assistant in Agricultural Physics in the Experiment Station.

Mr. U. S. Baer, for many years an instructor in the Dairy Department, resigned December 1, 1903, to become Assistant State Dairy and Food Commissioner. He was succeeded by Mr. W. J. Carson of Kingston, Ontario, appointed April 1, 1904. Mr. Carson is a graduate of the Ontario Agricultural College, serving that institution for some time as a traveling dairy instructor and later filling the position of instructor in milk testing and lecturer in dairy chemistry at the Kingston, Ontario, dairy school. His title is Instructor in Dairying in the College and Assistant Dairy Husbandman of the Station.

Mr. Frederick Cranefield, Instructor in Horticulture, and Assistant in Horticulture in the Experiment Station, resigned April 1, 1904, to assume the important duties of Secretary of the Wisconsin State Horticultural Society. He was succeeded July 1, 1904, by Mr. Walter S. Brown, a graduate of Alfred University, New York, and later of Cornell University, where he was graduated from the agricultural course. His title is the same as was that of Mr. Cranefield.

Mr. W. B. Richards, Instructor in Animal Husbandry, and Assistant in Animal Husbandry in the Station, resigned June 30, 1904, to assume the position of Assistant Professor of Animal Husbandry in the North Dakota Agricultural College. He was succeeded by Mr. J. G. Fuller, who was graduated with the last agricultural class of this college. His title is assistant in Animal Husbandry in both College and Station.

Mr. Henry J. Ramsey, Assistant in Cranberry Investigations, closed his work with the horticultural department June 30, 1904.

The Farmers' Course.—In our efforts to spread agricultural knowledge and acquaint our farmers more definitely and fully with the work of the College and Experiment Station, there

was instituted during the winter of 1904 what is known as the Farmers' Course. This embraced instruction covering a period of two weeks, beginning February 5, 1904, given only to persons over twenty-five years of age. No fees were charged to residents of the state. Lectures began at eight o'clock each week-day morning, and these with demonstrations and meetings of various kinds, occupied most closely the time of the farmer pupils. The President of the University and several professors of other colleges assisted in the entertainment and instruction of this class. It is interesting and important to record a total attendance of 170 in the Farmers' Course, representing forty-two different counties in the state. A number of those in attendance were over sixty years of age. There is promise of a larger class the coming year when the course will be repeated. It is our ambition to make the two-weeks stay of farmers at the University of the highest importance and value to all parties concerned. The agricultural interests of Wisconsin are paramount and no other class of citizens are in position to be more directly benefited by the University than our farmers. The Farmers' Course is designed for busy, business farmers who can leave home for but a short time, yet who desire to gain for themselves the great advantages, educational and otherwise, that await them at their state University.

Fire Protection.—During the fall of 1903 the University installed a new system of water supply, the effort being especially directed to better fire protection. An 8-inch cast-iron pipe was at that time extended as far as the Dairy building and several hydrants placed in the vicinity of the agricultural buildings grouped on Observatory Hill. During the fall of 1904 the 8-inch pipe system is being extended as far as the Dairy barn, and additional hydrants will be placed wherever needed. Hose carts, an ample supply of hose, fire lanterns, axes, and other accessories for fighting fire, will be installed. When all is completed the Agricultural College will for the first time have adequate fire protection at a cost of over $4,000 for that portion directly utilized by this college. The importance of this addition to our equipment becomes apparent when we remember that the buildings of this college represent an outlay of over

$300,000, and within them is housed about $100,000 worth of personal property. In these buildings are books, apparatus and many articles which could not be replaced were they once destroyed.

Improved Varieties of Plums and Apples.—Years ago our lamented Professor Goff started extensive experiments with seedling American plums and apples, in the effort to produce for Wisconsin hardy and superior varieties of these two important fruits. The seedling apple orchard is now bearing quite abundantly and Mr. Sandsten reports several promising varieties.

Efforts to improve the wild or *Americana* plum, which is entirely hardy and grows wild all over our state, likewise give promise of important results. Already several thousand seedling plum trees have borne fruit, and here and there one is found which possesses superior excellence; all such are carefully preserved, while those trees which do not show superior merit are at once rooted up and removed from the grounds to make way for still other seedlings. We now have in our trial grounds as a result of these selections a number of choice seedling plums, and the ultimate success of giving to our people several choice hardy, prolific plums seems practically assured. Large exhibits of seedling apples and plums are made annually at the State Fair in Milwaukee, where they are presented for inspection by the public generally and for special study by experts in such matters. Wisconsin horticulturists and nurserymen are invited to visit the Station horticultural grounds in proper season to study these fruits as they grow on the trees.

Potato Spraying Experiments.—The great area devoted by Wisconsin farmers to the potato crop, especially in the central portion of our state, makes every effort by this Station toward advancing that industry of prime value and interest to a large number of people. The potato blight is an ever threatening menace, and causes large losses to growers annually. Up to the present time our potato growers have done little to ward off this evil. Believing that the Station can be of direct help in this line, an extensive series of experiments have been undertaken the present season by Mr. Sandsten on the farm of Mr.

Soren Jensen of Waupaca. At this farm a power sprayer and hand sprayers are on trial in a field of thirty-seven acres of growing potatoes. Farmers were invited through the newspapers and by postal cards to be present on certain days when the spraying operations were in progress, to witness the efforts to check potato blight. The attendance at such times has been large and deep interest is taken in the work. It is hoped that the Station may secure means by which these efforts can be extended to all the principal potato growing sections of the state.

Studies of Moorland or Peat Soils.—The Agricultural Physics Department has undertaken studies of the peat or moorland soils, especially of the central and northern parts of the state. Such studies have been forced upon us through the frequent complaints coming to us concerning the unsatisfactory crop yields of such lands when reduced to cultivation. In a number of cases holders have drained and subdued these moorlands, planting various crops thereon, in expectation of securing abundant harvests. Oftentimes the first crop has been large and satisfactory, while the second was poorer, and succeeding ones gave still smaller returns, until discouragement took the place of ambition and hope. The cause of this surprising condition is being carefully looked into by Mr. Whitson and efforts are in progress to bring about a permanent, profitable improvement of such soils, if it is possible. Investigations of these soils are being carried on in Marinette, Wood and Juneau counties. A preliminary report of the findings to date appears elsewhere in this report.

A number of years since a study of muck soils was begun by Professor King; this line is being continued on the University Farm and at Whitewater.

Tobacco Investigations.—Experiments to test the value of various fertilizers in improving the yield, and especially the quality of tobacco, are in progress on farms in Columbia, Rock, Crawford, Vernon and Eau Claire counties. It is believed that the application of specially selected commercial fertilizers will materially improve the quality of the tobacco leaf, in certain regions of our state at least, and thereby increase the income of tobacco growers.

Last year a quantity of tobacco seed from especially selected plants was grown by us on the farm of Mr. A. L. Fisher of Rock County. This seed was distributed among the leading growers of the state last spring, and plantations resulting therefrom are showing superior quality at this writing. This year two acres of seed tobacco will be grown in Vernon and Rock counties for the production of seed. All the poor plants in these fields will be removed and seed allowed to mature only on the choicest specimens. Such seed will be distributed next spring.

Experiments are also being conducted by Mr. Sandsten in the growing of Sumatra tobacco under cover at Soldiers Grove, Crawford county. There is reason to believe that this is a particularly choice section of the state for efforts of this character.

Cranberry Investigations.—Our Cranberry station, located near Cranmoor, Wood county, is being placed in satisfactory condition and promises important results. Wisconsin has lands peculiarly adapted to the growth of this splendid and universally appreciated fruit. The Wisconsin Cranberry Growers' Association is one of the most intelligent and progressive societies in the state, maintaining a splendid organization and accomplishing much good for the cause. Our Cranmoor station is closely watched by the different members of this organization. At that station the various varieties of cranberries are being studied as to the yield, quality of fruit and general desirability for market purposes. Many varieties are under trial. This line is in charge of Mr. Sandsten.

Not less important is the study of the water supply of cranberry plantations, how much is required, how it can best be stored, and its quick and proper distribution; these are subjects coming directly under the study of Mr. Whitson.

Nursery Inspection.—Chapter 180, laws of 1899, provides that the Director of the Experiment Station shall, through his agent, inspect nursery stock for San Jose scale or other injurious insects and fungus diseases. It further provides for the destruction of infested plants in certain cases; also, that all trees and shrubs shipped into the state must carry a tag showing that they have been inspected by an authorized party

and are free from dangerous insects or diseases. The Director of this Station is authorized to issue to those whose nurseries have been properly inspected, shipping tags, to be attached to packages of fruit trees, vines, etc. All nurseries applying for inspection shall pay the sum of $5.00 for each ten acres of land used for nursery purposes. In carrying out the provisions of this act for the past two years, Mr. Christian Bües, of Ithaca, N. Y., was employed. Last year Mr. Bües found the San Jose scale, a much dreaded pest, in one nursery in the state. The infested plants were all carefully destroyed, and an examination for the summer season of 1904 fails to reveal the pest at the point originally affected or elsewhere in the state. Mr. Bües' work has been conducted with great intelligence and care. The nurserymen of the state are to be congratulated upon thus far having practically escaped from the San Jose-scale scourge and from most of the other serious insect pests as well. During the season of 1904 Mr. Bües found asparagus rust on nursery stock of the asparagus plant in two cases. This is a serious menace to an important industry among gardeners. Precautions were taken to prevent the spread of the disease.

While the nursery inspection law works some seeming hardship upon nurserymen, all will agree that anything which tends to keep our trees and vines free from pests, works for the good of all parties concerned. It is believed that by strictly carrying out the provisions of the law we can keep certain pests out of the state; or, should they finally gain entrance, hold them well in check. As our cultivated areas spread and our cultivated plants increase in numbers and density, we are more and more threatened with decimating pests; only by adopting and putting into practice the most vigorous preventive and destructive measures where such pests are found, can we hope to hold them in check and secure profitable returns for labor expended.

Mr. Bües' report as Nursery Inspector for the year 1904, in condensed form, is presented in this report.

The Wisconsin Agricultural Experiment Association.—Former students of our Agricultural College, principally members of the Short Course, some years since formed an association for mutual improvement and the advancement of agriculture in our

commonwealth. Their efforts have been mainly along the line of growing improved varieties of seeds and plants. An annual meeting is held in Madison, which is largely attended by the members. A fee of fifty cents is paid by each member toward maintaining the association, and its membership limited to persons who have at some time been in attendance at the College of Agriculture. The success of the association from its inception has been remarkable. The legislature of 1903 recognized its worth to the commonwealth by voting an annual appropriation thereto of $1,000 and further directing that there be printed, at public expense, 5,000 copies of its annual report.

Mr. R. A. Moore, Agronomist of this Station, is Secretary of the Association. He reports a paid membership of nearly six hundred. During the past year members have undertaken experiments in growing alfalfa, improved varieties of field corn, the Swedish oat, introduced by this Station through the U. S. Department of Agriculture, Washington, Dwarf Essex rape and the Soy bean. Its members have also conducted numerous trials to ascertain the best method of preventing oat smut through the use of formaldehyd. Students of agricultural progress will at once recognize the importance and value of this association to our commonwealth. To be effective in the highest degree an experiment station should be in direct contact at as many points as possible with the farmers scattered over the state. Our former agricultural students now on their farms, represent youth, energy and intelligence. Our station is in direct touch with these young men, and through them with the great body of farmers, so that whatever is found to be good and helpful in the advancement of agriculture can be quickly and effectively disseminated throughout the whole state.

Commercial Fertilizers in Wisconsin.—In 1895 a law was passed by our legislature by which each and every brand of commercial fertilizer sold within the state at a cost of $10.00 or more per ton, must pay an annual license fee of $25.00 to the Experiment Station and submit samples for analysis. Further, the packeges containing such fertilizer must bear a guarantee as to the nitrogen, phosphoric acid and potash content. Although the amount of commercial fertilizers used at the present time

New Agricultural Building, University of Wisconsin. The large auditorium in the rear of the building is not shown in this cut. The roof of the Horticulture-Physics building appears in the background to the right, while at the extreme left is shown the cupola of the Horse Barn

in the state is small, there is a gradual and steady increase through the demands of market gardeners, small fruit growers, tobacco growers, and to some extent the growers of peas for the canning factory. During the past year eighteen brands of commercial fertilizers were licensed for sale in the state.

Each year during the month of April an annual bulletin is issued giving a list of all licensed brands of fertilizers, together with other useful information. Farmers and others interested are urged to familiarize themselves with the provisions of the law and aid the Station in carrying them out. Information on the subject appears elsewhere in this report.

Feeding Stuffs Law.—During recent years there has been an enormous increase in the output of by-products from the various manufactories of human food products, such as the oatmeal mills, flouring mills, etc. There are also vast quantities of linseed oil meal, cotton-seed meal, etc., offered annually to the stockmen of the country. Most naturally these by-products offer an inviting field for manipulation and fraud to individuals of low commercial integrity. There is a constant effort by certain people to produce adulterations of many kinds which work great loss to stockmen purchasing such materials for feeding their animals. The gravity of the situation brought about the feeding stuffs law of 1901, by which the manufacturers of various concentrated feeding stuffs are compelled to annually pay a license fee of $25.00, for each distinct brand, to the Experiment Station, and to guarantee on each package the percentage of protein and fat the feeding stuff contains. In carrying out the fertilizer and feeding stuffs law the Station employs a traveling inspector, who is in the field most of the year. Mr. Roy T. Harris has served acceptably in this position. The general supervision of the work, as well as the analytical determinations, are in the hands of Chemist Woll.

For the year closing June 30, 1904, fifty-four brands of feeding stuffs have been licensed for sale in the state. The good effects of the law are apparent in several ways. In one instance a car load of bran adulterated with live weed seeds to the extent of twenty-eight thousand such seeds for each pound of bran was forced out of the state after it had been offered for sale. A

number of low-grade products have been kept out of the state entirely.

Bulletins of information on the feeding stuffs law are issued at least annually, copies of which will be sent to any resident of the state upon request. Our stockmen are urged to buy no concentrated feeding stuff, coming within the provisions of the law, without the proper guarantee plainly labeled on the package. Any infringement of the law should be promptly reported.

Official Dairy Tests.—Many years ago in its efforts to awaken a proper interest among the owners of pure-bred dairy cattle in the matter of milk and butter-fat produced for definite periods by cows of great excellence, this Station offered to send, at its own expense, a representative to determine the yield of milk and butter-fat of any particular cow. Only a most limited number of applications were received for aid under this most liberal offer. A change occurred, however, when in 1894 the Holstein-Friesian Association of America adopted a system of one-week milk and butter-fat tests for its Advanced Registry. At once there came from owners of Holstein cattle in our state calls for assistance. It soon became apparent that we must withdraw our offer of free service, else the Station would suffer heavy financial loss; instead, therefore, of testing the cows gratis, we asked the owners to meet one-half the expense; later they were asked to meet all of the direct expenses of the person conducting the test, such as compensation, traveling expenses, etc.

At no time, however, have we asked that the heavy expense falling on the Station for supervising this work, such as conducting chemical analyses, keeping the records, directing the movements of the representative testers, etc., be met by the breeders or the breed associations. It would appear that the time is now at hand for the Station to be relieved of this heavy expense. Such a suggestion becomes the more apparent when the statistics of this effort are considered. Previous to the year covered by this report there have been tested by representatives of this Station 943 cows in all, nearly all of the tests lasting seven days.

For the year just closed Professor Woll, who has the matter in charge, reports the following:

"a. Seven-day tests: Holstein cows 230, Guernseys 3, Jerseys 5, other breeds (Shorthorn, Red Polls, Brown Swiss, and grades) 10, total 248.

"b. Thirty-day tests: 21, all of Holstein cows.

"c. Thirteen- to sixty-day tests: 10, likewise all Holstein cows, making a total of 279 tests conducted for a period of seven to sixty days, against 171 tests during the year 1902–03.

"The number of pure-bred cows included in these tests aggregates 250. In addition, one-day tests occurring monthly were made of 73 Guernsey cows and 4 Jerseys, the greater number of these tests continuing throughout the year.

"Nearly all persons conducting these tests were graduates of the Short Course or Dairy Course. Thirteen young men were employed during the past year; during the winter months when this work was heaviest, six to eight simultaneous tests were in progress, that many different men being employed at the same time."

For the year ending June 30, 1904, breeders paid into the Station treasury $2,316.68 for their tests. This sum was in turn paid out at once to the persons conducting the tests as compensation and expenses.

The above shows most plainly that the official testing of pure-bred dairy cows is growing rapidly in volume and importance in this state. Our Station is proud of its record in this great work. We believe that a vast deal of good has already been accomplished, and that all of this is but a forecast of greater good still to come, provided the efforts can be conducted in the future with all the care and vigor the cause demands.

As the situation now stands Mr. Woll is unable to carry on these duties as he should and at the same time attend to other matters specially placed in his charge. The Station urges the breeders of the state to take such action in the matter as will lead to securing a specialist at the Station who will hereafter give his whole time to pushing this one line of dairy effort. We believe that the movement is well worth the cost of such a man

and that the Station has earned his services by what it has done for the dairymen.

Our Method of Conducting Special Investigations.—It has frequently been urged upon the Director of this Station that there should be established at various points in Wisconsin branch experiment stations. The argument in behalf of this idea is that the soil and climatic conditions at Madison are such as to necessarily render it impossible for our particular farm and surroundings to represent any considerable part of the state. We are told that because of this situation other parts of the state are suffering for aid which cannot be rendered from Madison. There is nothing more plausible to the novice in these matters, than the establishment of branch stations for agricultural research as a means of quickly and successfully solving a whole lot of knotty agricultural problems of special importance to the particular districts of the state. Our situation in this regard is not different from that of other commonwealths, and an examination soon reveals the fact that various other states of the Union, widely scattered, have in times past established branch stations similar to those so often urged for our own state. A study of the conditions in such states shows that very often their legislatures have enthusiastically appropriated considerable sums of money for the purchase of necessary land, the erection of buildings and for starting the branch station in its work. The same examination will show, however, that the career of these stations has been far from satisfactory. Legislatures usually fail to appreciate the cost of research work and in most cases after the first liberal appropriation, the funds available for the branch stations have been so meager that they have come in most cases to lead but a struggling existence. It costs far more money to maintain buildings, grounds, secure equipment and pay the expenses of the necessary labor and expert services at these branch stations than people generally deem necessary. To keep up these stations and at the same time properly maintain the central station is a heavier burden than the state usually cares to bear. The result is a struggling, weak institution turning out far less results than were anticipated.

The National government has ruled that none of the funds allowed by the Hatch Act coming from the government treasury shall be used for the support of branch experiment stations. This throws their maintenance wholly upon the state. It is not surprising, therefore, in view of all the circumstances that many of the states have already abandoned, in some instances all, and in other cases nearly all, of these branch stations, finding it far better to concentrate their efforts at a central point than to follow diffusive methods.

The Director of this Station has held that, for the present at least, and until our legislature is more liberally inclined than at present, it is better to maintain a strong central Station at Madison, and in no case attempt to build up permanent branch stations with all the attendant expenses incident to purchasing land, putting up of buildings, securing equipment, and paying for the experts and laborers that should be attached to such branch stations. At the same time it is recognized that there are numerous agricultural problems demanding solution which may best be studied at the point of greatest interest, which is often elsewhere than Madison. To reach and solve these we believe it is unnecessary to purchase land, erect expensive buildings, employ a corps of scientists and experts, and to start a miniature experiment station, with all attendant expenses. Far better is it to attack these special and local problems in the most direct manner possible by experts from the central Station. Land sufficient for these special and local experiments can usually be rented for a period of years for a merely nominal sum, and the owner of the land can usually assist in providing the necessary manual labor, aid in keeping records, etc. The temporary station so established can be visited from time to time by the representative expert in charge, from the central Station, who will stay at the grounds for indefinite periods when necessary. Having but a single line of effort under supervision, the mind of the person in charge is not diverted from the main issue, but every energy is directed towards its solution. If the location is found unsatisfactory or better ones develop, a change can be made or the effort extended at no great cost.

In illustration of our recognition of the necessity at times of conducting investigations elsewhere than at Madison and of choosing special temporary sites instead of locating permanently, we present the following:

Our Station is now conducting extensive cranberry studies, as elsewhere reported, at Cranmoor, on rented lands, these efforts being greatly aided by the Wisconsin Cranberry Growers' Association as such and by several individual members. A considerable range of tobacco experiments are in progress in several counties on lands where the rentals for land are merely nominal. In the same manner peat and muck soil experiments are being conducted in several counties. Members of the Agricultural Experiment Association, in close touch with this Station, are conducting many trials with improved varieties of seeds and plants. Thus the work of the Experiment Station is spreading well over the state and accomplishing a vast good, while the expenses of such effort are exceedingly small. Indeed the outlay in all these efforts is but the merest fraction of what it would be were we to undertake for the same end the establishment of permanent branch stations with all the necessary accessories. We believe that when our citizens come to understand the economy and efficiency of this movement they will give it their full endorsement and see that it has the liberal support it so much merits.

Publications.—During the year ending June, 1904, the Experiment Station issued the following publications:

No. of Bulletin	Title.	Size of Edition.	Pages.	Total pages.
101	Shrinkage of Cold Cured Cheese During Ripening	7,000	30	210,000
102	Studies in Milk Production	18,000	88	1,584,000
103	Soiling Crops for Dairy Cows in Wisconsin	18,000	14	252,000
104	The Food Requirements of Pigs from Birth to Maturity	18,000	51	918,000
105	The Improvement of Home Grounds	20,000	39	780,000
106	Licensed Commercial Feeding Stuffs, 1903	18,000	55	990,000
107	Official Tests of Dairy Cows, 1902-3	18,000	43	774,000
108	Trees and Shrubs for Shade and Ornament	25,000	60	1,500,000
109	Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1904	14,000	10	140,000
110	Spraying Fruit Trees	20,000	28	560,000
111	Oat Smut and Its Prevention	50,000	10	500,000
112	Alfalfa in Wisconsin	20,000	10	200,000
113	Licensed Commercial Fertilizers and Feeding Stuffs, 1904	15,000	22	330,000
114	A Lesson in Bovine Tuberculosis	20,000	8	160,000
		281,000	468	8,898,000
	20th annual report	15,000	414	6,210,000
	Total pages report and bulletins	296,000	882	15,108,000

The above shows that durng the year there were published by the Station fourteen bulletins and an annual report, containing 882 pages of printed matter, prepared by the workers of the Station. During the year 15,108,000 pages of printed matter in the form of an annual report and bulletins were distributed from the Station, nearly all going to the farmers of Wisconsin. Numerous newspaper bulletins on various agricultural subjects were also sent to all the papers in the state as well as to the agricultural press generally.

Most of our earlier publications are now out of print. The following is a complete list of bulletins issued by the Experiment Station to date. Those not starred are still available for distribution to residents of the state:

LIST OF BULLETINS ISSUED BY THE WISCONSIN AGRICULTURAL EXPERIMENT STATION, 1883-1903.

*No. 1. Sweet Skim Milk; Its Value as Food for Pigs and Calves.
*No. 2. Amount and Condition of Seed Corn in Wisconsin.
*No. 3. Composition and Digestibility of Fodders.
*No. 4. Experiments on Milk Production.
*No. 5. Analyses of Feeding Stuffs.
*No. 6. Experiments on Calf-feeding: Analyses of Fertilizers.
*No. 7. Experiments on Calf-feeding: The Cooley System of Creaming Milk.
*No. 8. Oil Meal vs. Corn Meal for Milk.
*No. 9. Report on Oats, Potatoes and Corn for 1885.
*No. 10. Tests of Dairy Cows.
*No. 11. Report on Wheat, Oats, Barley, Potatoes and Corn for 1886.
*No. 12. The Oil Test for Cream.
*No. 13. Report on Wheat, Oats, Barley, Corn and Potatoes for 1887: The Station Vineyard.
*No. 14. Artificial Fertilizers and Land Plaster.
*No. 15. Ensilage vs. Corn Fodder for Milk Production.
*No. 16. A New Method for Determining Fat in Milk.
*No. 17. Report on Corn, Oats, Barley and Potatoes: Grape Growing.
*No. 18. The Constitution of Milk, and Some of the Conditions which Affect the Separation of Cream.
*No. 19. Notes on Ensilage.
*No. 20. Noxious Weeds of Wisconsin.
*No. 21. Comparative Value of Warm and Cold Water for Milch Cows in Winter.
*No. 22. Report on Oats, Barley and Potatoes for 1889.
*No. 23. Prevention of Apple Scab.
*No. 24. A New Method for the Estimation of Fat in Milk, Especially Adapted to Creameries and Cheese Factories.
*No. 25. Feeding Bone Meal and Hard Wood Ashes to Hogs Living on Corn.
*No. 26. Sugar Beet Culture in Wisconsin.
*No. 27. The Feeding Value of Whey.
*No. 28. The Construction of Silos.
*No. 29. Creaming Experiments.
*No. 30. Sugar Beet Experiments in Wisconsin for 1891.
*No. 31. Notes on the Use of the Babcock Test and the Lactometer.
No. 32. Feeding Grain to Lambs.
*No. 33. Rations for Dairy Cows.

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*Out of print.

*No. 34. Preventive Treatment for Apple Scab, Downy Mildew and Brown Rot on the Grape, Potato Blight and the Smut cn Wheat and Oats.
No. 35. Insects and Diseases Injurious to Cranberries.
*No. 36. Directions for Using the Babcock Milk Test and the Lactometer.
*No. 37. The Russian Thistle.
*No. 38. One Hundred American Rations for Dairy Cows.
*No. 39. Noxious Weeds.
*No. 40. Tuberculosis and the Tuberculin Test.
*No. 41. Grain Feeding Lambs for Market.
No. 42. Destructive Effects of Winds on Sandy Soils and Light Sandy Loams, with Methods of Protection.
No. 43. The Agricultural, Horticultural and Live-Stock Features of a Portion of Wisconsin Tributary to Superior.
*No. 44. Pasteurization of Milk and Cream for Direct Consumption.
*No. 45. Apple Culture.
*No. 46. Power Tests of Centrifugal Cream Separators.
*No. 47. Wisconsin's Fertilizer Law.
No. 48. The Conn Culture (B. 41) in Butter-Making.
*No. 49. The Maintenance of Soil Fertility: Commercial Fertilizers.
*No. 50. The Hot Water Treatment for the Prevention of Smut on Oats, Wheat and Barley.
*No. 51. The Marls of Wisconsin.
*No. 52. A Comparison of the Babcock Test and the Gravimetric Method of Estimating Fat in Skim Milk.
The Alkaline Tablet Test of Acidity in Milk or Cream.
No. 53. Analyses of Licensed Commercial Fertilizers.
*No. 54. The Restoration of the Consistency of Pasteurized Cream.
*No. 55. Beet Sugar Production: Possibilities for a New Industry in Wisconsin.
*No. 56. Statistics from Fifty-two Wisconsin Separator Creameries.
*No. 57. Analyses of Licensed Commercial Fertilizers.
*No. 58. The Rape Crop, Its Growth and Value for Soiling and Fattening Sheep and Swine.
*No. 59. The Construction of Silos and the Making and Handling of Silage.
No. 60. The Cheese Industry: Its Development and Possibilities in Wisconsin.
No. 61. The Constitution of Milk, with Especial Reference to Cheese Production.
No. 62. Tainted or Defective Milks: Their Causes and Methods of Prevention.

*Out of print.

*No. 63. The Culture of Native Plums in the Northwest.
*No. 64. Sugar Beet Investigations in Wisconsin During 1897.
No. 65. A Bacterial Rot of Cabbage and Allied Plants.
*No. 66. Analyses of Licensed Commercial Fertilizers.
*No. 67. Factory Tests for Milk.
No. 68. One Year's Work Done by a 16-Foot Geared Windmill.
*No. 69. Pasteurization as Applied to Butter Making.
*No. 70. Construction of Cheese Curing Rooms for Maintaining Temperatures of 58 Degrees to 68 Degrees F.
No. 71. Sugar Beet Investigations in Wisconsin During 1898.
No. 72. Small Fruits in 1898.
No. 73. Analyses of Licensed Commercial Fertilizers, 1899.
*No. 74. A Study of Dairy Salt.
No. 75. Testing Cows at the Farm.
No. 76. Noxious Weeds of Wisconsin.
No. 77. Effects of the February Freeze of 1899 upon Nurseries and Fruit Plantations in the Northwest.
No. 78. The History of a Tuberculous Herd of Cows.
No. 79. Principles of Construction and Maintenance of Country Roads.
No. 80. The Character and Treatment of Swamp or Humus Soil.
No. 81. Analyses of Licensed Commercial Fertilizers, 1900.
No. 82. Experiments in Grinding with Small Steel Feed Mills.
No. 83. Silage, and the Construction of Modern Silos.
No. 84. Bovine Tuberculosis in Wisconsin.
No. 85. Development and Distribution of Nitrates and Other Soluble Salts in Cultivated Soils.
No. 86. Analyses of Licensed Commercial Fertilizers, 1901.
*No. 87. Native Plums.
No. 88. Dairy Industry in Wisconsin.
No. 89. The Law Regulating the Sale and Analysis of Concentrated Feeding Stuffs in Wisconsin.
*No. 90. Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1902.
No. 91. Oat Smut in Wisconsin.
No. 92. Licensed Commercial Fertilizers and Concentrated Feeding Stuffs, 1902.
No. 93. Development and Distribution of Nitrates in Cultivated Soils.
No. 94. Curing of Cheddar Cheese, with Especial Reference to Cold-Curing.
No. 95. Some Observations on Sheep Breeding from the Experiment Station Flock Records.

*Out of print.

No. 96. Investigations of Methods of Milking.
No. 97. Licensed Commercial Feeding Stuffs, 1902.
No. 98. On the Prevention of Oat Smut and Potato Scab.
*No. 99 Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1903.
No. 100. Licensed Commercial Fertilizers and Feeding Stuffs, 1903.
*No. 101. Shrinkage of Cold-Cured Cheese During Ripening.
No. 102. Studies in Milk Production.
No. 103. Soiling Crops for Dairy Cows in Wisconsin.
No. 104. The Food Requirements of Pigs from Birth to Maturity.
No. 105. The Improvement of Home Grounds.
No. 106. Licensed Commercial Feeding Stuffs, 1903.
No. 107. Official Tests of Dairy Cows, 1902–03.
No. 108. Trees and Shrubs for Shade and Ornament.
No. 109. Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1904.
No. 110. Spraying Fruit Trees, With Notes on the Common Insects and Fungus Diseases Infesting Orchards.
No. 111. Oat Smut and Its Prevention.
No. 112. Alfalfa in Wisconsin.
No. 113. Licensed Commercial Fertilizers and Feeding Stuffs, 1904
No. 114. A Lesson in Bovine Tuberculosis.

Reports and Bulletins Wanted.—We have many calls from public libraries, and from colleges and experiment stations for copies of former reports and bulletins. The following are out of print and very much desired: Annual reports of the Agricultural Experiment Station, I, III and VII; bulletins of the Agricultural Experiment Station, 1 to 11, inclusive; also 13 and 15.

Friends of the Station who are not keeping files of our publications, are earnestly urged to return to us any copies they may have of the rare reports and bulletins. We will gladly pay a reasonable sum for any of the lacking numbers above noted. Readers should bear in mind that the documents asked for are Experiment Station bulletins and reports, and not bulletins of the Farmers' Institute, which is another branch of the College of Agriculture.

*Out of print.

WHOLE CORN COMPARED WITH CORN MEAL FOR FATTENING PIGS: EIGHTH YEAR TRIAL.

W. A. HENRY.

In the twentieth annual report of this Station appears a summary of trials extending over seven years in which whole shelled corn was used in opposition to corn meal as a feed for fattening swine. In these tests 210 hogs in all were used, 105 on each side of the experiment. Over 112,000 pounds of feed was used in these trials, producing over 22,000 pounds of gain, live weight. In all cases some heavy wheat middlings was fed along with the corn or corn meal, as it was recognized that hogs even when quite mature cannot make satisfactory gains for any considerable period of time when maintained solely on corn. A summary of these trials shows that it required 516 pounds of shelled corn and middlings combined (about two-thirds shelled corn and one-third middlings) to make 100 pounds of gain, live weight, while 480 pounds of corn meal and middlings (same proportion as before) were likewise required for 100 pounds of gain. Thus it will be seen that there was a saving of 36 pounds, or, in round numbers, seven per cent. of grain, by reducing the corn to meal before feeding it, in combination with middlings, to rather mature hogs when fattening.

DESCRIPTION OF LAST YEAR'S EXPERIMENT.

As already stated, in these experiments about one-third of the ration (the exact amount being stated in each experiment) consisted of heavy wheat middlings. It was decided that in our next experiment we would omit the middlings and use corn as

the sole feed in order to ascertain what would be the result under such conditions. The pigs used in these trials were pure-bred Berkshires, those in Lots I and II ranging in weight from 104 to 168 pounds, and averaging 126 pounds; those in Lots III and IV were younger, ranging in weight from 72 to 97 pounds, and averaging 83 pounds. They had been well nurtured up to the beginning of the experiment, on a mixed variety of feeding stuffs. During the trial of ten weeks Lots I and III were maintained on whole shelled corn together with water, salt and hardwood ashes, freely supplied; Lots II and IV were fed corn meal made by grinding the same corn as was used with Lots I and III in a buhrstone mill at the University Farm. The corn was No. 3, Iowa grown, mixed yellow and white, more than one year old at the time it was fed. One week's preliminary feeding, not here reported, was conducted, in order to accustom the animals to feed and environment.

The amount of feed consumed and weekly gains of the several animals on trial, together with totals, are presented in the following tables:

Table showing results of feeding whole corn in comparison with corn meal to pigs.

Lot I, fed whole shelled corn.

	Feed eaten	1 B*	2 B.	3 S.	4 B.	Total.
	Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs.
Weight at beginning, January 25th	....	168	116	117	104	505
Feed and gain:						
1st week	121.5	6	6	3	8	23
2nd week	112	9	8	6	7	30
3rd week	112	5	3	0	4	12
4th week	107.5	7	3	7	1	18
5th week	105	6	4	5	6	21
6th week	112	6	5	5	6	22
7th week	112	7	6	3	3	19
8th week	119	8	4	4	9	25
9th week	119	5	5	2	3	15
10th week	119	8	3	4	8	23
Final weight	......	235	163	156	159	713
Feed eaten and gain	1,139	67	47	39	55	208

* B = Barrow; S = Sow.

Lot II, fed corn meal.

	Feed eaten.	1 S.*	2 B.	3 S.	4 S.	Total.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Weight at beginning, January 25th	....	136	126	122	123	507
Feed and gain:						
1st week	138	1	4	4	4	13
2nd week	126	8	11	11	4	34
3rd week	133	0	1	2	11	14
4th week	140	11	10	6	9	36
5th week	140	5	0	7	8	20
6th week	140	8	4	6	8	26
7th week	140	6	6	6	9	27
8th week	154	7	4	12	9	32
9th week	154	8	6	8	9	31
10th week	143	1	1	2	9	13
Final weight	....	191	173	186	203	753
Feed eaten and gain	1,408	55	47	64	80	246

* B.=Barrow; S.=Sow.

Table showing result of feeding shelled corn in comparison with corn meal to pigs.

Lot III, fed whole shelled corn.

	Feed eaten.	1 S.*	2 B.†	3 S.	Total.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Weight at beginning, Jan. 25th	....	90	85	75	250
Feed and gain:					
1st week	60.5	—1	2	0	1
2d week	56	6	4	4	14
3d week	56	—1	1	1	1
4th week	44	4	6	1	11
5th week	42	1	0	0	1
6th week	35	7	4	....	11
7th week	34.25	0	1	....	1
8th week	35	5	2	....	7
9th week	38.5	2	3	....	5
10th week	42	6	2	....	8
Final weight	....	119	110	81	310
Feed and gain	443.25	29	25	6	60

Lot IV, fed corn meal.

	Feed eaten.	1 S.*	2 S.	3 S.	Total.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Weight at beginning, Jan. 25th	....	82	72	97	251
Feed and gain:					
1st week	71	1	—5	0	—4
2d week	70	4	5	5	14
3d week	70	1	0	5	6
4th week	77	8	5	7	20
5th week	77	4	6	5	15
6th week	43	2	....	—1	1
7th week	49	2	....	4	6
8th week	44.5	—4	....	4	0
9th week	39	4	....	1	5
10th week	42	3	....	5	8
Final weight	....	107	83	132	322
Feed eaten and gain	582.5	25	11	35	71

* S = Sow. † B = Barrow.

The tables show that Lot I required 548 pounds of whole shelled corn for 100 pounds of gain, while Lot II required 572 pounds of corn meal, a difference of 24 pounds in favor of feeding whole corn. Coming to the duplicate trial with the younger pigs, it is shown that Lot III required 738 pounds of whole shelled corn for 100 pounds of gain, while Lot IV required 820 pounds of corn meal for 100 pounds of gain, a loss by grinding of 82 pounds of corn in producing 100 pounds of gain.

In these trials none of the pigs did as well as they should. The older lots consumed their feed with more satisfaction and made fairly good gains. When all conditions are favorable, 500 pounds of shelled corn should produce 100 pounds of gain with well fatted hogs; for short feeding periods less grain will suffice. These older hogs required from 48 to 72 pounds more than a good average. Coming to the younger lots, we find an enormous food consumption for the small gains made. Lot III, getting whole shelled corn, required 238 pounds, and Lot IV, 320 pounds more than a reasonable average requirement. These pigs did not thrive on this restricted diet and were dissatisfied with their feed almost from the start. Pig No. 3 in Lot III was withdrawn from the trial the fifth week of the experiment, as was Pig No. 2 in Lot IV, both being unable to longer continue on the trial.

So far as these trials are concerned, it is shown that in both cases there was a waste of food by reducing the corn to meal by grinding.

CORN ALONE UNSUITABLE FOR HOGS.

If it were the purpose of this Station to always manage its feeding experiments so as to show the best possible gains from a given amount of feed, these experiments would never have been undertaken. The experience of swine feeders generally has shown that when hogs are closely confined in pens with wood floors, they cannot for any considerable length of time make satisfactory gains when their feed consists wholly of shelled corn or corn meal. Mature hogs under confinement will show large gains for several weeks on the exclusive corn diet, but such gains are not long continued. Young growing pigs must build

up bone and muscle, if they are to increase materially in weight and grow normally; they cannot secure from the corn grain the necessary food elements for the body structure, and hence nature, soon turned awry, protests against this food by showing poor appetites, lack of gain, and other evidences of unthrift and malnutrition.

The purpose of this experiment was to determine whether or not there was advantage in reducing whole corn to meal for fattening pigs. The results plainly show that corn, either ground or whole, should not be used exclusively with pigs or young hogs. So far as they are of any value otherwise, they show a positive disadvantage following the grinding of the corn to meal. So disastrous were the results that it is doubtful if we are warranted in continuing such experiments with pigs.

SOME EFFECTS OF FEEDING WIDE AND NARROW RATIONS ON THE GROWTH OF YOUNG PIGS.*

J. G. FULLER.

This experiment was conducted for the purpose of studying the effect of feeding wide and narrow rations to young pigs; or, in other words, to compare the results of feeding a corn ration against a mixed ration. Investigations previously conducted at this Station show that by feeding it is possible to vary the proportion of fat to lean in carcasses of pigs. It was further found that by feeding pigs on corn meal alone, the constitution of the animals was impaired. Since these facts have been found to be true of fattening pigs, it was the object of this investigation to study the effects of practically the same feeding on the growth of pigs started at about fifty pounds and extended over a period of time sufficiently long to develop them into marketable pigs.

As corn is one of the most important feeds we have for swine, it is of value to know just what results will be reached by feeding it exclusively to young and growing pigs. With this object in view, it was decided to feed one lot of pigs on corn meal alone, and another lot on a mixed ration of corn meal, wheat middlings and skim milk. In so doing, it was possible, by comparing the two lots, as the experiment progressed, to study the effects produced by feeding the respective rations.

*Synopsis of a thesis submitted for the degree of Bachelor of Science in Agriculture, University of Wisconsin, 1904.

PLAN OF THE EXPERIMENT.

Six pure-bred Berkshire pigs were used. Five of them were from one litter. These six pigs were taken from their dams several days before the experiment began. On October 20th, 1903, three days before the trial actually started, the pigs were divided into two lots, with three pigs each. In doing this every precaution was taken to get the two lots as evenly divided as possible. From this time on Lot I was known as the "corn meal pigs," and Lot II, the "mixed ration pigs." Fortunately, on this date, both lots weighed the same amount, 155 lbs. The first three days were given up to preliminary feeding. This was done for the purpose—of getting Lot I on the exclusive corn ration. It will be noticed from one of the tables following that, October 23rd, when the experiment actually began, that both lots did not weigh the same as was the case three days previous. This is undoubtedly due to the fact that Lot I suffered from the change in their ration, while being put on the corn diet. On the contrary, there was no material change in the ration of Lot II, and they kept right on making gains. Lot I received all the corn meal they would eat. This was fed wet, having been thoroughly soaked with water to make a thick slop. When the trial began, each pig in this lot was eating about 1½ lbs. of corn meal per day.

Lot II was fed on equal parts of corn meal and wheat middlings (by weight) and enough skim milk to make a thick slop. When the trial began, each pig in this lot, was eating about two pounds of dry feed per day and getting twice that amount of skim milk.

Feeding stuffs used.

	Digestible nutrients in 100 pounds.			
	Protein.	Carbo-hydrates.	Ether extract.	Nutritive ratio.
	Lbs.	Lbs.	Lbs.	
Corn meal	7.9	6.67	4.3	1-10
Wheat middlings	12.8	53.0	3.4	1- 5
Skim milk	2.9	5.3	.3	1- 2

Table showing cost of production.

	Lot I.	Lot II.
Weight Oct. 23, 1903	157 lbs.	161 lbs.
Weight Feb. 10, 1904	287 lbs.	523 lbs.
Pounds of corn meal fed	919	541
Pounds of middlings fed	....	647.2
Pounds of skim milk fed	....	231.9
Pounds gained in weight	130	362
Pounds of dry food per pound of gain	7.12	3.33
Total cost of feed	$6 58	$13 81
Value Oct. 23, 1904	$6 28	$6 44
Total cost of pigs	$13 86	$20 25
Value Feb. 10, 1904, at 5c per lb	$14 35	$26 15
Net profit	$ 49	$5 90

The table shows plainly the results obtained by feeding young pigs entirely on corn. In the first place, we find that Lot II receiving the mixed ration, made almost three times the gain made by Lot I. Lot II made one pound of gain on 3⅓ lbs. of dry feed while it took 7.15 lbs. of corn meal for one pound of gain in Lot I. Figuring the cost of the feed at market price at the time of the experiment and valuing the young pigs at four cents per pound, October 23d, 1903, and 5 cents per pound when the trial ended, we find that Lot II made a profit of $5.90, while that made by Lot I was but forty-nine cents.

The figures show partially the serious effects resulting from exclusive corn feeding to young pigs. From the time the experiment began, until it ended, the physical condition of the pigs in Lot I gradually became more and more unnatural, while Lot II rapidly developed into ideal pigs. The feeding trial made dwarfed animals out of every pig in Lot I, fed exclusively on corn. While they gained some in flesh, they did not develop in bone, and as time went on, their vitality decreased. The hair on their bodies became thin and their skin hard and scaly. Toward the end of the trial, they were indifferent about eating and showed considerable uneasiness.

On February 10th, 1904, the day the experiment ended, both lots were taken to a slaughtering house and slaughtered. Ample provision was made for carrying out the slaughter test. A skilled butcher with an assistant did the work.

Table showing the results of slaughter test.

No. of pig.	Live weight.	Dressed weight.	Per cent of dressed weight.	Weight of stomach	Weight of lungs.	Weight of liver.	Weight of heart.	Weight of kidneys.	Weight of blood.
LOT I.	Lbs.	Lbs.		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
236	103	75	72.8	4.3	2.3	1.5	.3	.3	2.6
244	84	60	72.2	2.7	1.6	1.1	.2	.2	2.3
239	100	70	70	3.6	1.7	1.4	.5	.1	2.4
LOT II.								diseased	
238	139	104	74.8	1.9	3.2	2.	.3	.5	5.7
232	194	147.5	76	2.3	2.2	2.8	.4	.7	6.2
237	190	147.5	77.6	1.3	2.8	2.6	.45	.7	5.5

Number of pig.	Weight of the small intestine.	Length of the small intestine.	Weight of the large intestine.	Length of the large intestine.	Weight of the fat from the intestines.	Weight of the leaf lard.	Weight of the tongue.	Weight of the hair.	Breaking streng'h of thigh bones.
LOT I.	Lbs.	Feet.	Lbs.	Feet.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
236	2.7	58	3.5	13.5	1.8	3.3	.4	4	1,120
244	2.3	53.2	2.6	12	1.1	2.1	.4	2	990
239	2.4	46.9	3.6	11.5	1.7	3.0	.4	4	1,105
LOT II.									
238	2.95	49.6	4.1	13.8	1.4	3.2	.5	5	1,275
232	4.8	62	7.7	14.5	2.2	5.3	.55	6	1,525
237	3.6	58.2	5.5	14.5	2.65	6.5	.6	7	1,690

From this table we find that, in every case, the pigs fed the mixed ration, dressed the highest per cent. While none of thees per cents are high, it should be remembered that we were dealing with young pigs, not fully matured. Strange as it may seem, we find that without exception, the lightest pigs, those in Lot I fed on corn meal, had the heaviest stomachs. The stomachs of these pigs were larger and heavier than those from Lot II. The walls of the stomach were thick and muscular, and the internal tissue bulky. Possibly the process of continually digesting the corn meal became so difficult for the young pigs, that it caused abnormal development of the stomach. On examining the intestines of the pigs in Lot I fed on corn meal, they were found to contain large quantities of worms. This was true of every pig in the lot. Two or more worms could be found at any point where the intes-

FIG. 1.—Shows a cross-section cut just in front of the shoulders of a representative pig from Lot I fed exclusively on corn. The one on the right is that of a pig from Lot II fed the mixed ration. The cut shows plainly the marked difference in carcasses as a result of the ration fed.

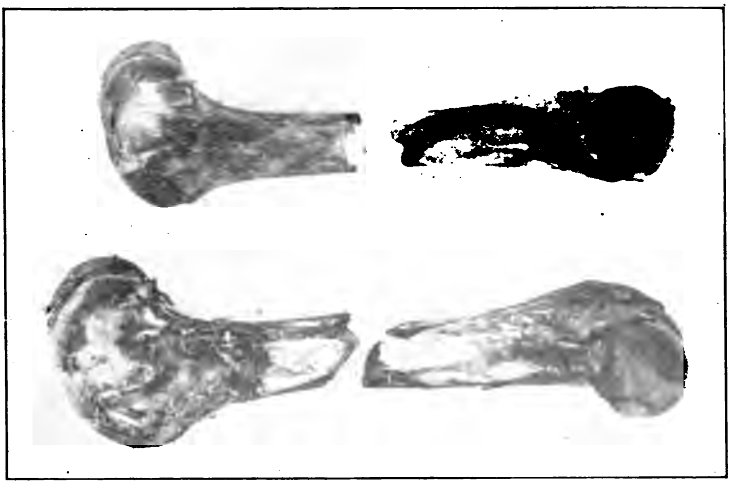


FIG. 2.—Shows the thigh bones of the least and greatest breaking strength. The smallest bone was taken from a pig in Lot I and broken at a pressure of 490 lbs.; the largest one from a pig in Lot II fed the mixed ration, and it broke at a pressure of 875 lbs. Besides the difference in size, the square brittle break of the small bone is to be contrasted with the splintering break of the large strong bone.

tines might be severed. This fact, however, was rather surprising, since the excrement of these pigs showed no signs of worms.

A representative pig was chosen from each lot for dissection and several photographs were taken of different parts of the carcasses for comparison. Since no further dissection was carried on with these carcasses, than simply making cross sections and cutting out the thigh bones, no definite conclusions can be drawn as to the exact proportion of fat to lean meat developed by the different feeding. While there are no figures to show that Lot II, fed on the mixed ration, developed a higher proportion of lean meat, in the carcass, than did Lot I, fed corn meal, such a conclusion might easily be arrived at from a study of the carcasses and cross sections. One point, however, was very noticeable, the lean meat of the pigs in Lot II, fed the combined ration, was much darker colored and showed better marbling, of the fat and lean, than the lean meat of the pigs, fed entirely on corn. The photographs, of the different cross sections and the broken thigh bones, show plainly the condition of the respective lots at the close of the trial.

The thigh bones of the pigs were an interesting study. They were taken from the carcass of each pig and broken in a testing machine, to determine their breaking strength. The cut represents two different fractures, each typical of its lot. The small bone is from Lot I, fed corn meal. The square break is characteristic of the manner in which all of the bones from Lot I broke when subjected to pressure. The large bone was stronger and the pressure resulted in a more irregular break. Each bone was broken separately and in the same position as the others. In this trial, as well as in previous investigations, the bones of the pigs in Lot II, fed the mixed ration, were much the stronger. The average breaking strength per bone, for the corn meal pigs, was 536 pounds, and for Lot II, 748 pounds. After the bones were broken, pieces from each lot were put on a hard coal fire and allowed to char. On examining them, it was found that the bones from Lot I crumbled into pieces like meal. Those from Lot II still remained quite

brittle and it took considerable pressure to crush them. This shows plainly that the skeletons of the pigs, in Lot I, lacked the necessary mineral matter for developing strong bones. From this we see that these pigs were inferior even in this last feature of the investigation.

CONCLUSIONS BASED ON THE INVESTIGATION.

First of all, it must be remembered that we were dealing with young and growing pigs at a time when they ought to be developing bone and muscle. Further, it must not be forgotten that the pigs in Lot I were subjected to unnatural treatment. No farmer pens his pigs up in small quarters, and then undertakes to mature them entirely on corn. But a large number of farmers are "burning the iron at a lower heat." They are feeding their sows corn, and their young pigs are raised largely on corn.

Then, as a practical result of this investigation, we have exemplified in Lot I what actually occurs in a less exaggerated degree, among the herds of many swine producers, and that, in one generation vigorous pigs of excellent type and breed, can be so injured in constitution by the ill use of corn, that they become practically worthless for breeding stock. In Lot II is demonstrated the ideal of what can be accomplished by the skillful feeding of a mixed and balanced ration.

The following are the actual conclusions derived from the experiment:

1st. That valuing both lots at the same price per lb. Lot II realized a profit practically four times that of Lot I.

2d. That the ratio of dry food per pound of gain for Lot I and II was as 1:2.

3d. That during the trial, Lot II made 4 1–5 times as great a gain in weight as did Lot I.

4th. That on the average, the thigh bones from Lot II were 50 per cent stronger than those from Lot I.

5th. That the constitution of each pig in Lot I was seriously impaired.

6th. Finally, that it is highly impracticable to raise growing pigs on a wide ration like corn alone.

SOY BEANS VS. MIDDLINGS AS A SUPPLEMENT TO CORN MEAL FOR FATTENING PIGS.

GEO. C. HUMPHREY.

Corn alone, in concentrated form, is not a satisfactory ration for either growing or fattening pigs. Experimentation and practice have proved that the best results are secured when the corn is supplemented with skim milk, some other grain, or some forage crop that will tend to form a balanced ration. Corn, being a highly carbonaceous feed, requires a supplement rich in protein. For pigs a mixture of corn and middlings has proved a very satisfactory ration, the only objection being the inconvenience and cost of securing the middlings at all times.

During the past few years considerable attention has been given the growing of the soy bean plant in this state, a plant bearing a concentrate rich in protein and oil as well. From general reports the plant seems well adapted to our soil and climate in those sections where Indian corn will grow and ripen. Since protein is an ingredient essential to every well calculated ration and costly to the farmer who must buy it, many have endeavored to grow soy beans upon their farms, with the hope that protein can thus be secured in a cheaper manner.

For the benefit of those who do not have in mind the composition and digestibility of the concentrates in question, the following table is given.

TABLE I—*Showing a comparison of the feeds under consideration.*

A—Composition of feeding stuffs.

	Total in 100 pounds of concentrates.					
	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Fat.
Corn	11.00	1.40	9.00	1.88	72.47	4.25
Middlings	12.10	3.30	15.60	4.60	60.40	4.00
Soy beans	10.53	6.20	36.25	4.15	25.97	16.90

B—Digestible nutrients in 100 pounds of concentrates.

	Dry matter.	Protein.	Carbohydrates.	Ether extract	Nutritive ratio.
Corn	81.0	6.8	68.5	3.65	1:11.3
Middlings	87.9	12.8	53.0	3.4	1:4.7
Soy beans	80.6	31.5	19.0	14.4	1:1.7

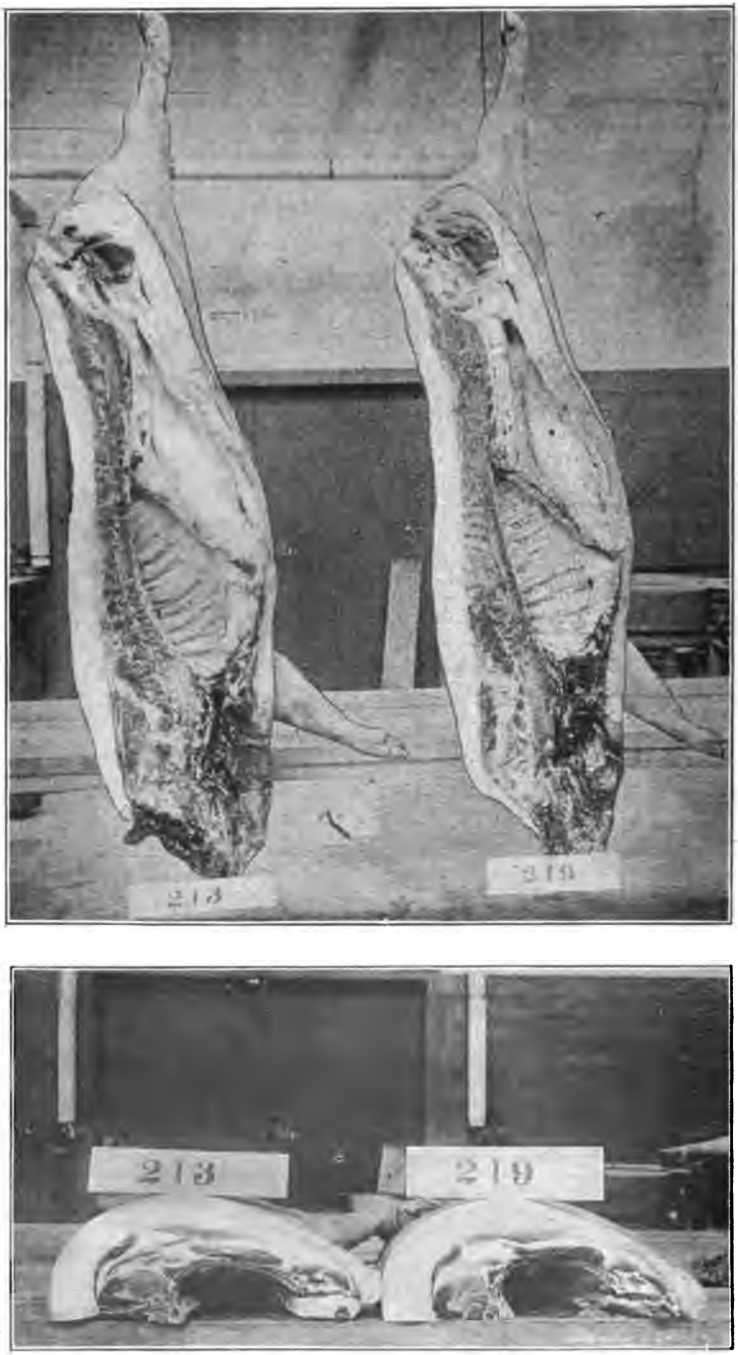
C—Digestible nutrients in 100 pounds of feed.

	Dry matter.	Protein.	Carbohydrates	Ether extract.	Nutritive ratio.
⅔ corn meal, ⅓ middlings	83.3	8.76	62.3	3.76	1:8
⅔ corn meal, ⅓ soy bean meal	80.8	15.0	52.0	7.43	1:4.6

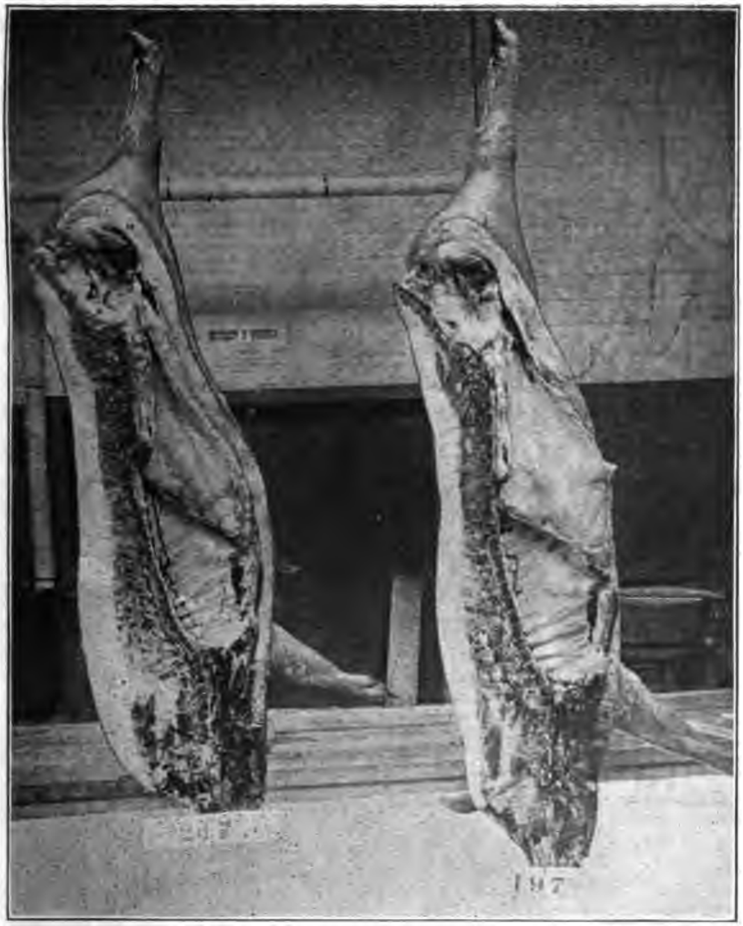
To learn something of the value of soy beans as compared with middlings to balance a corn ration for pigs, a trial was made at the Station during the past winter, as herewith reported.

OUTLINE OF THE TRIAL.

Six pure-bred Improved Yorkshire pigs were selected and divided into two equal lots. Care was taken to have both lots as uniform as possible as regards size, thrift, and quality. The pigs were selected from two spring litters, and were eight months old when the trial commenced. Each lot contained two sows and a barrow, all of which were in splendid condition to take on flesh rapidly.



FIGS. 3-4.—Corn meal with soy-bean meal (219), and middlings (213).



FIGS. 5-6.—Corn meal with soy-bean meal (197), and middlings (217).

The two lots were confined in a single pen and turned into individual feeding pens twice each day, where they were fed and a record made of the amount each pig consumed. Lot I received a ration of two thirds corn meal and one third soy bean meal. Lot II received a ration of two thirds corn meal and one third middlings. Owing to the difficulty of grinding the soy beans alone, the corn and soy beans were mixed in their proper proportions and then ground, which did away with the trouble mentioned. The feed was mixed with water which was warmed during the very cold weather, and fed in the form of a thick slop. Both lots had free access to salt and ashes during the entire feeding period of thirteen weeks. The trial began December 28, 1903, after a preliminary trial of one week, and the following tables shows the amount of feed eaten and the gains made.

TABLE II.—*Showing amount of feed eaten, initial weight, and gains in weekly periods.*

Lot I.—Corn meal and soy bean meal.

	Sow No. 197.		Barrow No. 199.		Sow No. 219.		Total feed.	Total weight and gain.
	Feed.	Gain.	Feed.	Gain.	Feed.	Gain.		
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Initial weight	....	225	....	210	....	239	....	674
1st week	48	4	51	11	59	14	158	29
2d week	42	9	46	9	55	12	143	30
3d week	54	22	46	4	44.5	15	144.5	41
4th week	52	—11	48.5	14	53.5	5	154	8
5th week	38.5	18	48.5	8	47.5	14	134.5	40
6th week	54	11	33	4	60	13	147	28
7th week	46	—16	46	1	56	8	148	—7
8th week	43	18	39	8	50	8	132	34
9th week	52	19	40.5	10	58	22	150.5	51
10th week	34	—14	45.5	11	57	6	136.5	3
11th week	50	25	42.5	8	39	—2	131.5	31
12th week	58	15	42.5	10	45	18	145.5	43
13th week	30	—13	39.5	8	58	17	127.5	12
14th week	58	28	43	8	42.5	—8	143.5	28
Total feed and gain	659.5	115	611.5	114	725.0	142	1,996.0	371
Final weight	....	340	....	324	....	381	....	1,045

Lot II. Corn meal and middlings.

	Sow No. 194.		Barrow No. 213.		Sow No. 217.		Total feed.	Total weight and gain.
	Feed.	Gain.	Feed.	Gain.	Feed.	Gain.		
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Initial weight	....	173	....	255	....	212	....	640
1st week............	40	—12	40	4	49.5	3	129.5	—5
2d week......... ...	31.5	23	49.5	8	53.5	18	134.5	49
3d week............	36	1	43	10	51	6	130	17
4th week............	31	—4	58	14	40	4	129	14
5th week............	42	13	62	8	55	13	159	34
6th week............	37.5	0	59	13	53.5	3	150	16
7th week............	36	8	62	13	50	3	148	24
8th week............	40	7	53	7	50	11	143	25
9th week............	32	—8	54	10	50	15	136	17
10th week............	37.5	20	56	13	45	7	138.5	40
11th week............	42	9	58	7	55	11	155	27
12th week............	24	—4	59	18	50	5	133	19
13th week............	40	13	58	11	30	8	128	32
14th week......	36.5	—5	57	8	57	11	150.5	14
Total feed and grain	506.0	61	768.5	144	689.5	118	1,964.0	323
Final weight..........	....	234	... .	399	....	330	....	963

TABLE III—*Summary of feed eaten and gains made by two lots.*

	Lot I.	Lot II.
Total gain lbs.	371	323
Per cent gain..	35.5	33.5
Total feed consumed lbs..	1,996	1,964
Average daily gain per head lbs..	1.26	1.08
Feed required per pound of gain lbs..	5.39	6.08

To note the influence of the rations on the pigs of the respective lots, further than the amount of feed consumed and the gains made, a slaughter test was made at the end of the feeding trial. The tables below and the accompanying cuts, made from photographs taken of the carcasses, go to show the results of this test.

TABLE IV—*Weight of carcasses and various organs of pigs when slaughtered.*

	Lot I.				Lot II.			
	Sow No. 197.	Barrow No. 199.	Sow No. 219	Average.	Sow No 194	Barrow No. 213	Sow No. 217.	Average.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Live weight	334	318	376	343	230	392	325	316
Dressed weight	269	263	311.5	281	186.5	329.5	272	263
Per ct. of dressed weig't	80.5	82 7	82.8	82	81	84	83.6	83 2
Weight of blood	11.2	7.6	9.0	9.3	7.4	10.5	8.3	8.7
Weight of liver	4.3	4.2	4.5	4.3	2.7	3.7	3.7	3.3
Weight of tongue	1.0	1.1	1.2	1.1	.9	1.0	.8	.9
Weight of heart	.8	.9	.9	.86	.75	.9	.8	.81
Weight of spleen	.4	.5	.5	.46	.4	.4	.4	.4
Weight of gall	.2	.2	.2	.2	.15	.15	.2	.16
Weight of lungs	6.1	4.4	5.2	5.2	4.9	4.8	3.7	4.4
Weight of stomach	2.8	3.4	4.0	3.4	2.1	2.4	2.6	2.4
Weight of bladder	.25	.2	.15	.2	.1	.2	.2	.16
Weight of intestines	16.0	11.7	14.0	13.9	7.9	14.0	11.4	11.1
Weight of kidneys	.62	.75	.87	.74	.5	.75	.75	.66
Weight of kidney fat.	9.8	15.0	10.0	11.6	8.0	16.0	13.0	12.3
Weight of intestinal fat	5.6	6.2	6.7	6.16	4.3	9.5	6.9	6.9
Length of intestines	96 ft.	81.5 ft.	88.5 ft.	88.6 ft.	76.0 ft.	81.0 ft.	67.5 ft.	74.8 ft.

TABLE V.—*Summary of slaughter test.*

	Lot I.	Lot II.
Shrinkage 30 hours off feed lbs.	17	16
Total live weight when killed lbs.	1,028	947
Total dressed weight lbs.	843	788
Per cent. of dressed weight	82	83.2
Per cent. of blood	2.7	2.7
Per cent. of tongues, livers and hearts	1.8	1.6
Per cent. of entire offal not fat	11	10
Per cent of intestinal fat	1.8	2.1
Per cent. of kidney fat	3.3	3.9

SUMMARY.

From the general results given in the foregoing tables, the ration of corn meal supplemented with soy bean meal, seems to have been the most favorable. The difference, however, in the results of feeding the two lots, must be considered very slight, for the reason that it is noticeable how uniform the amounts of feed consumed and the gains made, were in the case of all pigs in the two lots, with the exception of sow No. 194 of

Lot II. Had pig No. 194 been a good feeder, there would not have been the difference in favor of the soy beans.

From Table I will be seen the value of soy beans as compared with corn and middlings in the amount of digestible protein and fat they supply. The amount of digestible protein in soy beans is nearly five times as great as that in corn, and two and one half times as great as that in middlings, while the amount of digestible fat is about four times that in the corn and in the middlings. In the ration of corn meal and soy bean meal given Lot I, the amount of digestible protein and fat was nearly twice that in the ration of corn meal and middlings given Lot II, while the nutritive ratio was much narrower, being only about one half as wide., The superabundance of protein supplied the pigs of Lot I in this trial, did not produce any marked results that would warrant incurring any extra expense in order to supply a ration so high in protein content. It remains to be proved what the results of this ration will be in other trials with perhaps younger pigs and also what the results will be in using a smaller amount of soy bean meal to supplement a corn ration.

In looking over Table II, showing the amount of feed consumed and the weekly gains, the most interesting point, perhaps, and one somewhat on a side line to the trial, is the periodical low gains or losses in weight in the case of the sows, which it was noticed, occurred each time they were in heat. With hardly an exception this was true, although, for the entire period, their gains were nearly the same as those of the barrows., Sow No. 194 was apparantly thrifty throughout the trial, but was a light feeder and made poor gains. It is of interest to note in Table IV the weight of the various internal organs of this pig as compared with that of the others. The digestive organs, the liver more especially, show a lack of capacity which undoubtedly accounts for the low gains made by this pig.

In judging the carcasses for the amount and distribution of fat and lean there was no marked difference. It was agreed by those who examined the carcasses carefully that there was a slight difference in the greater amount and better developed

lean meat in carcasses produced by feeding corn supplemented with soy beans. There was not enough difference, however, to bring out the fact clearly as will be seen from the accompanying cuts. The age of the pigs at the time of the commencement of the trial, undoubtedly had some effect upon the muscle development which might come from feeding a highly nitrogenous ration. In taking out the kidney fat, there seemed to be a smaller amount of it for the soy bean lot than the per cent given in Table V would indicate. The variation in the amount of intestinal fat was not great, the greatest variation occurring within Lot II which received the ration of corn meal and middlings. No definite conclusions can be drawn from this single trial, and results of further trials will be sought with interest.

YIELD AND COMPOSITION OF SOW'S MILK.*

L. R. DAVIES.

The objects of this experiment were to determine, so far as possible, the quantity and composition of milk produced by a sow; the amount of food necessary to produce 100 lbs. increase in weight of suckling pigs; to compare day gains with those made at night, and incidentally to ascertain possible effects due to temperature influnces.

The subject of the experiment was a pure-bred Berkshire sow, in good condition and about to farrow. When the litter of seven pigs was farrowed on the morning of July 31st, 1903, each pig was weighed separately, and tagged in the ear. Throughout the experiment the pigs were weighed night and morning prior to feeding.

DETERMINING MILK YIELD.

At periods of two, six and ten weeks from birth, the pigs were weighed prior to feeding and immediately after nursing, to ascertain the daily milk yield of the sow. The weighings were made, at each period, during two consecutive days, every two hours during the day and at three hours intervals during the night. In determining the daily yield of milk, allowances were made as carefully as possible for weight of excrement voided by pigs while nursing. The methods followed in determining the milk yield by weighing the pigs before and after nursing was identical with that adopted in experiments reported in Bulletin 104 and the Fourteenth Annual Report of this Station. Space does not permit the

*Thesis submitted for the degree of B. S. in Agriculture, University of Wisconsin, 1904. Synopsis by A. S. Alexander.

printing of the tables giving in detail the weights of milk yielded at the various periods of testing throughout the experiment. Suffice it to say, that the average daily yield of milk proved to be 5.56 lbs. or, as closely as could be estimated, a total yield of 389.20 lbs. for the 70 days of the trial.

It was further shown that the milk flow gradually decreased following parturition. From the second to the sixth week the decrease was .85 lbs. in the daily yield, or 13.4%; from the sixth to the tenth week, .85 lbs. or 15.4%, or, in other words, a decrease between the second and tenth week of 1.7 lbs. in the daily record, or 26.0%. Comparing these results with those previously recorded at this Station, it is seen that all of the sows mentioned in Bulletin 104 showed an average decrease in the daily production of 2.38 lbs. of milk, or 38.0%, while the Berkshire sows, in the experiment there reported, showed an average decrease of 3.70 lbs., or 43.0%.

While these figures, perhaps, indicate that the milk flow of the single Berkshire sow tested in the present experiment appears abnormally low the data collected to date, scarcely justifies the conclusion. All things considered, the results attained serve to corroborate the assertion made in Bulletin 104 to the effect "That there is as much variation in the amount of the milk given by different sows as there is among dairy cows."

METHOD OF MILKING.

Four weeks after farrowing a sample of milk was secured for analysis. The plan adopted for securing the sample was the same as that followed in previous experiments of the same character at this Station. The pigs were allowed to nurse until the milk flow started, then one was removed qnietly and the vacated teat milked by hand into a small vessel, from whence it was transferred to a sample bottle containing a few drops of formaldehyde as a preservative. The process of extraction was found extremely difficult. But a few drops could be secured at each trial so that the total amount of milk gradually collected for analysis may have been assumed to have been a fair composite sample. It was noticed in the course of

this work that the milk was most easily extracted from the second and third teats, counting from the rear of the udder. When an attempt was made to extract milk from the front teats, the sow almost immediately objected and held back her milk or started to her feet and walked excitedly about the pen.

COMPOSITION OF SOW'S MILK.

The method followed in analyzing samples of sow's milk obtained in this experiment and in previous experiments conducted at this Station, is that adopted by the Association of Official Agricultural Chemists. The material for the subjoined table was obtained from "The Composition and Digestibility of Feeding Stuffs" by Dietrich and König (Vol. 1, p. 865; Vol. II, p. 1278); the Fourteenth Annual Report of this Station, and Wisconsin Bulletin 104.

TABLE III—*Composition of sow's milk, different analyses.*

Authority.	No. of samples	Water.	Total solids.	Fat.	Solids not fat.	Casein and albumen.	Sugar.	Ash.	Specific gravity.
		Pr. ct	Pr ct.	Pr ct.	Pr ct.	Pr ct.	Pr ct.	Pr ct.	
Range	....	81-89	10-18.3	1.0-9.2	......	5.1-8.5	1.6-6.1	.8-1.5	....
Dietrich and Konig	7	84.5	15.45	4.75	10.40	6.44	3.16	1.10	....
Henry and Woll	7	80.96	19.04	7.06	11.99	6.20	4.75	1.07	1.0389
Range	....	79-83	17-20	3.9-9 5	.. ..	5.3-7.3	3.1-6.0	.8-1.3	1.035—1.0454
Carlyle and Woll	12	80.5	19.5	6.9	12.60	6.06	5.64	.98	1.0412
Range	....	78-82	17.6-21	5 5-8.8	11.6-14.7	5.2-8.1	5.19-6.41	.8-1.21	1.0372-1.0479
Berkshire only.									
Carlyle and Woll	4	80.4	19.59	7.25	12.31	5.74	5.63	.97	1.0396
Range	....	78.7-82.4	17.6-21.2	5.5-8.8	12.01-12.47	5.4-6	5.26-6	.86-1.06	1.0372—1.0421
Davies	1	83.28	16.72	5.41	11.31	4.76	5.47	1.08	1.033

From the above table it will be noted that the milk from the single sow of the present experiment was higher in water content and ash than the average for Berkshire or other sows, other than those tested in Germany.

TABLE IV—*Feed for gain — Weekly summary showing amount of feed consumed by sow with gain or loss in weight.*

Days from farrowing.	FEED OF SOW.					Weight of sows, lbs.	Gain or loss, lbs.
	Corn, lbs.	Shorts, lbs.	Oil meal, lbs.	Bran, lbs.	Skim milk, lbs.		
Before....	....	....	....	....	....	424	....
After....	....	....	....	....	....	392	32
7	12.6	17.1	....	....	149	387	— 5
14	28.0	28.0	....	....	112.3	380	— 7
21	35.0	35.0	....	....	140	387	+ 7
28	35.0	35.0	....	....	140	401	+14
35	35.5	35.5	....	....	142	394	— 7
42	37.5	37.5	....	....	150	399	+ 5
49	35.0	35.0	.4	....	140	399	0
56	37.2	26.8	4.4	1.7	140	398	— 1
63	35.0	35.0	6.5	....	140	389	— 9
70	32.0	32.0	7.0	....	128	399	+10
Total...........	322.8	316.9	18.3	1.7	1,381.3	....	—25
Daily average..	4.61	4.52	.27	.02	19.73	....	....

The table shows that a total of 659.7 lbs. of grain and 1381.3 lbs. of skim milk was consumed by the sow during the ten weeks after farrowing.

FEED FOR MAINTENANCE.

To determine what proportion of the feed was utilized by the sow for her individual maintenance, and what proportion went to the maintenance of her pigs, the feeding period was extended five weeks. In order to accomplish this object, the pigs were weaned and the feed somewhat reduced the first week, then increased, decreased, or held stationary according to the judgment of the experimenter. The results attained were that the sow lost 8 lbs. in weight during the first week; gained 4 lbs. the second week, although the feed had been further reduced, but fell off during the third and fourth weeks a total of 7 lbs. with further reduction of food. When, from the ninty-eighth day forward, the feed was increased by 4 lbs. of grain and 8 lbs. of skim milk (.1 lb. each of corn and shorts with .4 lbs. of skim milk at both feeding times) the sow's weight did not vary more than three pounds above or below 394 lbs., although the average daily ration was lower than that fed during the first two weeks and a half after weaning. The

averages were: corn 12.1 lbs.; shorts 1.21 lbs. and skim milk 48.4 lbs. for the week, while the average weight of the sow was 392.3 lbs. These averages would total 242 lbs. of grain and 484 lbs. of skim milk as necessary for the maintenance of the sow for ten weeks, and the food consumed in excess of those amounts, may be assumed to have been utilized for the maintenance of the pigs. Deducting the grain and skim milk, used for maintenance from 659.7 lbs. of grain and 138.3 lbs. of skim milk, the total amount fed, we have an excess of 417.7 lbs. of grain and 897.3 lbs. of skim milk.

TABLE V.— *Feed of pigs for gain: records of temperature.*

Corn.	Shorts.	Bran.	Skim milk.	Weight of Pigs. No. 223.	No. 220.	No. 222.	No. 244.	No. 225.	No. 226.	No. 227.	Total	Gain.	Average daily temperature.
				Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs	Lbs.	Lbs	Lbs.	
.....	.....	......	......	*3.4	*3.4	*2.8	*3.4	*2.6	*2.6	*2.8	*21.0	....	......
......	......	......	......	5.5	6.1	4.7	6.0	5.3	4.4	5.2	37.2	16.2	67.5°
......	......	......	......	8.7	9.9	9.3	9.0	8.8	7.5	8.5	61.7	24.5	66.3°
......	.....	......	......	10.5	13.2	11.9	11.1	11.0	9.9	10.6	78.2	16.5	68.3°
......	.....	......	....	13.8	18.9	16.1	15.8	14.3	13.6	14.4	106.9	28.7	67.1°
......	......	......	......	17.0	21.8	19.7	19.8	18.0	17.8	18.0	132.1	25.2	63.2°
......	......	......	......	21.1	26.5	24.2	22.6	21.0	21.5	21.4	158.3	26.2	63.9°
5.0	.5	......	3.3	26.5	31.7	30.6	26.0	25.6	26.9	27.7	195.0	36.7	57.9°
8.8	.....	2.4	47.8	33.2	36.9	36.0	31.0	27.2	32.2	35.2	231.7	36.7	60.5°
17.3	13.3	2.4	105.0	40 4	42.9	42.8	37.5	31.7	36.2	41.3	272.8	41.1	56.4°
23.0	23.0	4.2	127.0	46.7	47.1	47.3	40.3	36.9	41.8	46.8	306.9	34.1	54.7°
54.1	36.8	9.0	312.8	.....	......	......	......	......	......	......	......	......	.....

* Initial weight at birth.

Total gain .... 285.9 lbs.
Daily average .... 4.07 lbs.

The table shows that the pigs were fed 99.9 lbs. of grain and 312.8 lbs. of skim milk. Adding these amounts to the excess of the maintenance ration of the sow, we get a total of 517.6 lbs. of grain and 1,210 lbs. of skim milk (ratio 1:2.32) producing a gain of 285.9 lbs. in the weight of the pigs. This is equivalent to 146.0 lbs. of grain and 338.7 lbs. of skim milk required for the production of 100 lbs. of gain in the live weight of pigs.

Of the 285.9 lbs. of gain shown in the foregoing table 83.5 lbs. were made during the day time and the balance (202.4 lbs.) was made during the night time. These weights were computed by adding together as day gains all of the evening

weighings, and as night gains all of the morning weighings. As the morning weighings were made sometime after sunrise and those of the evening some time before sunset the difference in favor of the evening weights cannot be wholly attributed to lack of exercise during the night.

EFFECT OF TEMPERATURE.

Careful records of the daily temperatures were kept and note taken of the effect of the temperature changes upon the weight of the pigs. On the nineteenth day after farrowing the temperature rose 10 degrees above the average of the preceding week and a loss of 1.1 lbs. in weight was noted. Thirty-one days from farrowing a decrease of 9 degrees in temperature, compared with that of the week previous, coincides with a loss in weight of 1.1 lbs. With an increase of temperature 33 days after farrowing a loss in weight was recorded and again a slight loss with a rising temperature on the thirty-eighth day, increasing when the mercury reached 72° F. the next day. Similar losses in weight during periods of increased temperature were noted on the forty-third, fiftieth, fifty-sixth, fifty-ninth and sixty-seventh days from farrowing. Falls in temperature on the fifty-eighth, sixty-ninth and seventieth days occasioned similar losses to those noted when the temperature increased.

The conclusion is that any sudden wide variation from the mean temperature lessens the increase or favors the decrease in weight of a litter of young pigs, other conditons remaining the same.

SUMMARY.

The results of the experiment warrant the following conclusions:

1. That the milk production of sows varies considerably according to breed, temperament, and feeding and is influenced by these factors to the same degree as with cows.

2. That pigs while young can be fed more economically per 100 lbs. gain in live weight than at any other time.

3. That suckling pigs make their chief gain in weight during the night time. Those in this experiment showing 70.89 per cent as the proportion in gain made at that time.

4. That marked variations in temperature affect the weight of pigs favorably or unfavorably while slight variations have no appreciable effect.

ON THE DAILY YIELD AND COMPOSITION OF MILK FROM EWES OF VARIOUS BREEDS.

J. G. FULLER AND FRANK KLEINHEINZ.

In the spring of 1902 an attempt was made under the supervision of Prof. W. L. Carlyle to determine the yield and composition of milk given by ewes of the various breeds in the station flock. For the trial herewith reported fourteen ewes were selected for the investigation which were typical of their respective breeds. Of the ewes chosen there were two Oxfords, two Southdowns, two Dorsets, three Shropshires, three Merinoes and two native Montanas. All of them lambed between the 30th of March and the 13th of April, 1902, so that when the experiment was conducted, May 26th to 30th, 1902, the lambs were at least seven weeks old and averaged in weight about 40 lbs.

To determine the daily milk yield of each ewe, the lambs were separated from the ewes and kept in separate pens, except when allowed to suckle. The lambs were allowed to suckle six times each day for two days. Before allowing each lamb to suckle its dam, it was put into a small box and carefully weighed. As soon as the lamb was through nursing it was weighed again. The difference between the weight of the lamb before and after nursing was recorded as the amount of milk suckled by the lamb. This was kept up two days and the yield of milk for each ewe for the two days was averaged to determine the daily yield of milk per ewe.

When the two days were up the experiment was continued to determine the difference between the amount of milk given by a ewe when suckled by a lamb and when milked by hand.

The third day the ewes were milked by hand five times. The total amounts of milk secured from each ewe were taken as her daily yield when milked by hand. A sample of each ewe's milk was preserved and analyzed.

From the data secured we compile the following table.

Table showing the yield and analysis of ewes' milk, classified as to breed.

No. of ewe.	Breed.	Amt. of suckled milk per day	Amt. of milk milked by hand per day	Difference.	Specific gravity.	Per cent fat.	Solids not fat.	Total solids.
		Lbs.	Lbs.	Lbs.		Per ct.	Per ct.	Per ct.
15833	Oxford	3.3	1.60	1.7	1.0381	7.4	11.005	18.405
99	Oxford	2.95	1.20	1.75	1.0376	7.9	10.980	18.880
	Average for the two Oxfords	3.12	1.4	1.72	1.0378	7.65	10.994	18.642
1859	Southdown	2.05	1.4	.65	1.0370	7.7	10.790	18.49
82	Southdown	1.65	.45	1.20	1.0385	9.1	11.445	20.545
	Average for the two Southdowns	1.85	.925	.925	1.0380	8.4	11.1170	19.5175
7645	Dorset	4.50	1.85	2.65	1.0385	7.1	11.045	18.145
1951	Grade Dorset	4.05	1.15	2.90	1.0370	7.3	10.710	18.010
	Average for two Dorsets	4.28	1.50	2.775	1.0378	7.2	10.3775	18.077
	Shropshire	2.5	.35	2.15	1.0380	6.15	10.830	16.980
1902	Shropshire Grade	2.6	.38	2.22	1.0395	6.40	11.115	17.555
119	Shropshire Grade	2.4	.90	1.50	1.0380	5.10d	10.5200	15.620
	Average for three Shrops	2.5	.543	1.957	1.03875	5.88d	10.821	16.718
334	Merino	1.9	.65	1.25	1.0395	6.45	11.165	17.615
95	Shrop. Merino	2.45	.85	1.60	1.0385	5.15	10.655	15.805
96	Shrop. Merino	2.65	.65	2.00	1.0375	6.4	10.655	17.055
	'Average for three Merinos	2.33	1.716	1.62	1.0380	6.00	10.825	16.825
40	Montana	3.40	1.00	2.40	1.0395	6.80	11.235	18.035
52	Montana	2.15	1.10	1.05	1.0380	7.50	11.000	18.500
	Average for two Montanas	2.72	1.05	1.725	1.0388	7.15	11.117	18.267
	Average for the 14 ewes	2.80	1.022	1.800	1.0381	7.05	10.875	18.174

One of the noticeable results brought out in the table, is the difference in the amount of milk yielded by the ewes when suckled and when milked by hand. In almost every case the lambs took double the amount secured by the milkers. Taking the average for each breed into consideration we find that the Dorsets yielded the largest quantity of milk, viz., 4.28 lbs. per

day, while the Southdowns gave the smallest quantity, a little less than 2 lbs. On testing the milk it was found that the Southdowns, with the smallest daily yield to their record, gave milk of the highest quality. The Shropshires giving about an average amount of milk per day showed the lowest percentage of fat.

Then as a result of this one investigation we find that only about one-half the daily milk yield of a ewe can be secured by milking; that in milk production the breeds represented in the station herd stand as follows: Dorsets, Oxfords, Montanas, Shropshires, Merinoes, and Southdowns, and that when compared with previous trials the average amount of fat, 7.05 per cent, was rather high.

THE VALUE OF SOY BEANS AS A PART OF A GRAIN RATION FOR LAMBS.

W. B. RICHARDS AND FRANK KLEINHEINZ.

The growing of soy beans has been greatly extended in this State during the past few years through the efforts of this Station. The high protein content of this plant is the principal reason for urging its cultivation. It is a legume and adds nitrogen to the soil by means of the tubercles found on its roots. Although not so well adapted to this northern section as it is to many sections in the south, there is much evidence to show that it can be grown profitably to balance the rations fed to our live stock.

Soy beans have heretofore been used for the most part as a forage crop or for silage purposes. At present more attention is being given to raising them for their grain, and the plan is meeting with considerable success. With the spread of this practice it is essential that more should be known of their feeding value.

The object of this experiment was to compare the feeding value of soy beans with oats fed as an adjunct to corn. Because of their high protein content, we assumed that they would be of great value to balance the corn ration. As the lambs to be used in the experiment were to be kept as breeding ewes it was not aimed to feed for large gains but to maintain them in good growing condition. Special attention was given to the manner in which the soy beans were relished by the lambs and whether they caused any ill effects.

Twenty ewe lambs were available for this trial and they were divided into two equal lots. The following breeds were represented and distributed as equally as possible in the two lots; pure-bred Southdowns, Shropshires and Hampshires along with grades of the first two breeds. The lambs were in good condition at the beginning of the experiment. They averaged 102.7 lbs. per head and the lots differed but a few pounds in weight. The experiment began January 20th, 1904, and was continued 12 weeks.

The grain ration fed lot 1 was composed of equal parts of soy beans and shelled corn. The amount of grain fed each lot for the first three weeks was 1 pound per lamb per day. After this time they received 1¼ lbs. per day.

About one pound of cut corn stover was fed to both lots each morning. For the evening meal they received approximately 1 pound of clover hay until March 2d. After this date they received as a substitute June grass hay. All roughage left uneaten was weighed and deducted from the amount weighed out for each lot.

TABLE I.—*Gains made and feed consumed by each lot.*

	LOT II.						LOT I.					
	Total weight.	Gain.	Grain fed.	Hay feed. Clover.	Hay feed. June grass.	Corn stover.	Total weight.	Gain.	Grain fed.	Hay fed. Clover.	Hay fed. June grass.	Corn stover.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Initial weight.........	1,025	.....	.....	.....	.....	.....	1,030	.....	.....	.....	.....	.....
End of 1st week.......	1,018	—7	70	55.5	.....	27.9	1,006	—24	70	54.8	.....	22.6
End of 2d week.......	1,042	24	70	68.2	.....	38.2	1,030	24	70	68.2	.....	34.2
End of 3d week.......	1,052	10	70	68.5	.....	44.5	1,052	22	70	68.7	.....	43.2
End of 4th week.......	1,044	—8	87.5	56.7	.....	40.7	1,046	6	87.5	56.0	.....	40.0
End of 5th week.......	1,063	19	87.5	.....	59.7	43.0	1,059	13	87.5	.....	58	41.6
End of 6th week.......	1,089	26	87.5	.....	58.3	46.0	1,101	42	87.5	.....	56.5	41.7
End of 7th week.......	1,095	6	87.5	.....	50.6	48.0	1,118	17	87.5	.....	51.0	44.0
End of 8th week.......	1,105	10	87.5	.....	50.0	43.8	1,139	21	87.5	....	51.2	41.5
End of 9th week.......	1,119	14	87.5	.....	51.0	42.5	1,149	10	87.5	.....	52.7	45.0
End of 10th week......	1,124	5	87.5	.....	50.4	44.4	1,155	6	87.5	....	50.9	43.0
End of 11th week.......	1.141	17	87.5	.....	50.8	49.3	1,184	29	87.5	.. .	51.7	44.8
End of 12th week.......	1,162	21	87.5	.	53.2	40.7	1,193	9	87.5	.. .	58.7	44.8

Summary Table.

	LOT I.	LOT II.
	Fed soy beans and corn.	Fed oats and corn.
	Lbs.	Lbs.
Average weight per head at beginning of experiment	103.0	102.5
Average weight per head at end of experiment	119.3	116.2
Average gain per head during the experiment	16.3	13.7
Average weekly gain per head	1.36	1.14
Total grain consumed	997.5	997.5
Total roughage consumed	1,159.8	1,181.9
Roughage consumed per pound gain	7.11	8.62
Grain consumed per pound gain	6.11	7.28

The tables show that the total gains made by the lot fed soy beans was 163 pounds while the other lot made a gain of 137 pounds. This rate of gain is equivalent to a weekly gain of 1.36 pounds for the lambs in Lot I and 1.14 pounds for those in Lot II. During the first week of the trial both lots lost in weight while becoming accustomed to the grain ration. The lot fed soy beans did not take to their grain during the first few days, but after that time they appeared to relish this grain.

There were times when lambs in this lot were off their feed for a day or two. Two of them scoured somewhat during two weeks of the trial. This might not have been due to the character of the grain ration, but to the weakness of some of the individuals in the soy bean lot.

It is difficult to make a comparison of the cost of the rations fed these lambs for the reason that no means of determining the cost of the soy beans is available at the present time. This trial, however, shows from the gains made in the experiment that one pound of soy beans is equal to 1.19 pounds of oats in feeding value.

We are indebted to Geo. A. Olson, Assistant Chemist of this Station, for the analysis of all the feed stuffs fed during this experiment with the exception of corn stover. The figures given for the composition of corn stover were taken from Prof. Henry's "Feeds and Feeding."

TABLE III.—*The analysis of the feeding stuffs used in this experiment.*

FEEDING STUFFS.	TOTAL IN 100 POUNDS.					
	Water.	Protein.	Crude fiber.	Nitrogen free extract.	Ether extract.	Ash.
Soy beans	10.53	36.25	4.15	25.97	16.90	6.20
Oats	6.08	10.13	13.25	62.19	3.25	4.40
Corn	11.00	9.00	1.83	72.47	4.25	1.40
Clover hay	7.50	12.88	29.98	42.19	2.15	5.20
June grass hay	6.08	10.88	24.78	47.73	2.83	7.70

The amount of dry matter and digestible nutrients in the daily ration fed Lot I.

	DIGESTIBLE NUTRIENTS.				
	Dry matter.	Protein.	Carbohydrates.	Ether extracts.	Nutritive ratio.
.59 lb. soy beans	.475	.185	.112	.085	....
.59 lb. corn	.477	.041	.404	.0214	....
.88 lb. clover hay	.50	.070	.47	.029	....
.58 lb. corn stover	.342	.007	.188	.004	....
Total	1.794	.303	1.174	.139	1:4.9

The amount of dry matter and digestible nutrients in the daily ration fed Lot II.

.59 lb. oats	.389	.046	.295	.016	....
.59 lb. corn	.477	.041	.404	.0214	....
.88 lb. clover hay	.500	.070	.47	.029	....
.58 lb. corn stover	.342	.007	.188	.004	....
Total	1.708	.164	1.357	.0704	1:9

The total digestible nutrients received by each lot in their daily rations were determined from the analysis of the feed stuffs consumed. In comparing the nutritive ratio of the rations a great difference is noticeable. The nutritive ratio of the ration containing soy beans was 1 : 4.9, while that of the ration containing oats was 1 : 9, the difference being due to the soy beans which contain over three times as much protein as oats.

Reference to the weekly gains made by each lot, shows that Lot II fed oats made better gains than Lot I, fed soy beans, before June grass hay was fed in place of clover hay. It occurred to the writer that it was possible that Lot II did not receive enough protein in this ration when June grass hay was

fed. A comparison of the amount of protein in the ration made by substituting the June grass hay for clover hay shows that the difference was not enough to bring about such results. The reason for the difference in gain at the beginning of the trial was evidently that it took the soy bean lot some time to become accustomed to this kind of grain.

Soy beans in this trial have proved to be an excellent grain for balancing the grain ration of growing lambs. More experiments will be necessary before definite conclusions can be drawn. If the results continue to be as encouraging as those set forth in this experiment, extended use of soy beans for feeding purposes will depend upon how economical their production proves in this particular section.

EXERCISE VS. CONFINEMENT FOR FATTENING SHEEP IN WINTER.

GEO. C. HUMPHREY AND FRANK KLEINHEINZ.

Whether to feed fattening sheep closely confined in pens or to feed them in pens and allow them to run part of the time in yards or fields for the sake of exercise, is a question that arises in the minds of men who feed a large number of sheep each winter. Exercise on the one hand, we know to be essential to a strong vigorous body and conducive to a keen appetite, two important things from a feeder's standpoint. Confinement on the other hand, conserves energy, which would otherwise be expended in exercising the body, and thus the probability of the assimilated food being converted into better and more economical gains is assured. With but these two ideas in mind, conclusions might be drawn that would lead men to follow either of the two systems of feeding.

The original intention of the feeding trials herewith reported, was not merely to settle the question of exercise versus confinement, but we regret that it is now impossible to report on more than this phase of the subject. It should be stated also that these trials were not conducted with the purpose of trying to make the largest and most economical gains. The nature of these feeding trials, however, provides data that furnish the result of two winter's work, showing the effect of exercise and confinement upon the gains and cost of gains in feeding lambs, and it is our object in this report to throw some light on the merits of the two systems. To Prof. W. L. Carlyle belongs the credit for outlining and superintending the trial made

during the winter of 1902–3. The trial made during the past winter is practically a continuation of the first.

In the first trial forty wether lambs were divided into four lots. The lots were made as uniform as possible as regards the breeds, quality, and weight, and all were fed the same kinds and amount of feed. The grain mixture consisted of bran, corn and oats, and the roughage of sugar beets and clover hay. Lots I and III received exercise each day the weather permitted, being turned into a large yard or driven to the field some distance from the barns. Lots II and IV were closely confined in feeding pens and received no exercise during the entire feeding priod. The feeding period commenced December 12, 1902 and continued for sixteen weeks. The amount of food consumed, the gains made, and the cost of gains for each lot during the feeding period is shown in the following summary table.

TABLE I—*Table for first trial, showing gain, feed consumed and cost of gain for each lot.*

	EXERCISED.		NOT EXERCISED.	
	Lot I.	Lot III.	Lot II.	Lot IV.
	Lbs.	Lbs.	Lbs.	Lbs.
Total gain made by each lot	203	218	194	215
Average weekly gain per head	1.267	1.358	1.211	1.337
Total amount of grain consumed	1,371.2	1,371.2	1,371.2	1,371.2
Total amount of sugar beets consumed	1,120	1,120	1,120	1,120
Total amount of hay consumed	1,988	1,988	1,988	1,988
Grain consumed per head per day	1.22	1.22	1.22	1.22
Sugar beets consumed per head per day	1.0	1.0	1.0	1.0
Hay consumed per head per day	1.77	1.77	1.77	1.77
Grain required per pound of gain	6.75	6.28	7.06	6.38
Roughage required per pound of gain	15.3	14.2	16.0	14.4
Cost of feed per pound of gain	$0.11	$0.10	$0.114	$0.103

In comparing the results of this trial of the lots receiving exercise with those not receiving exercise, the slightness of variation is somewhat surprising. It should be mentioned, however, that during the sixteen weeks or 112 days, during which time Lots I and III should have received exercise, twenty-six of these days were stormy and necessitated keeping the lots confined. This may account to some extent for the absence of greater variations.

In the second trial which was conducted during the winter of 1903–4, thirty-two wether lambs were divided into two lots. They were pure-bred and high grade lambs, and all in higher condition of flesh than the average class of feeders one secures on the market. Several of the lambs were choice specimens which had been exhibited the previous fall at the International Live Stock Exposition. Both lots were given the same kinds and amount of feed, the grain mixture consisting of bran, corn and oats, and the roughage of mangels and clover hay. Lot I received exercise each day the weather was suitable, while lot II was closely confined throughout the period, extending to ninety-one days. During this time, Lot I was confined eight days on account of inclement weather. The following summary table shows the amount of feed consumed, the gains made, and the cost of gains for each lot.

TABLE NO. II— *Table for second trial, showing gain, feed consumed, and cost of gain for each lot.*

	Exercised. Lot I.	Not exercised. Lot II.
	Lbs.	Lbs.
Total gain made by each lot	190	283
Average weekly gain per head	.91	1.33
Total amount of grain consumed	1,456	1,456
Total amount of mangels consumed	2,632	2,632
Total amount of hay consumed	2,912	2,912
Grain consumed per head per day	1.0	1.0
Mangels consumed per head per day	1.8	1.8
Hay consumed per head per day	2.0	2.0
Grain required per pound of gain	7.6	5.14
Roughage required per pound of gain	29.1	19.6
Cost of feed per pound of gain	$0.151	$0.102

TABLE III—*Final summary table for the two trials.*

	Lots Exercised.	Lots not Exercised.
	Lbs.	Lbs.
Average weekly gain per head	1.18	1.29
Average amount of grain required per pound of gain	6.87	6.19
Average amount of roughage required per pound of gain	19.5	16.6
Average cost of feed per pound of gain	$0.12	$0.106

The results obtained in the second trial show considerable variation between the gains and the cost of the gains made by the lot receiving exercise and the lot receiving no exercise. The variation is also in favor of the lot receiving no exercise, which is contrary to the results of the first trial. The average results for the lots receiving exercise in both trials and the same for the lots receiving no exercise, from the data set forth in the foregoing table, the advantage, while not great, is still in favor of confinement for fattening sheep in winter. The report should be accepted as partial, however, since further work is necessary to settle the question satisfactorily.

EFFECT UPON THE LAMBS OF FEEDING A MIXED GRAIN RATION OF CORN, OATS, AND BRAN TO PREGNANT EWES.

W. B. RICHARDS AND FRANK KLEINHEINZ.

In the 17th and 18th Annual Reports of this Station experiments were reported, showing the effect of feeding different combinations of roughage with the same mixed grain ration to pregnant ewes. The 19th Annual Report contains the result of feeding various single grain rations with the same roughage mixture. For roughage, corn silage and hay were used since they gave the best satisfaction in the previous trials.

The work mentioned above was conducted by Prof. W. L. Carlyle and the experiment here reported was also planned and supervised by him.

This experiment herein reported was conducted to compare the results of feeding a mixed grain ration to breeding ewes with the single grain ration set forth in the 19th Annual Report. It was the object of these trials to determine a system of feeding which would give the best results in maintaining ewes in ideal condition during pregnancy, yield the largest supply of milk at parturition, and produce a maximum crop of vigorous lambs. As the kind of roughage fed during both trials was the same, and the consumption practically the same, a just comparison can be made of the grain rations fed.

For this experiment forty ewes from the Station flock were divided into four equal lots. The lots were made as uniform as possible as regards the age, weight and breeding of the component individuals.

Each lot was fed the same grain and roughage ration. The grain ration was composed of 1 part corn, 1 part oats and 1 part bran. The experiment began December 20th and until February 21st each ewe received ½ lb. of grain per day and after that date they received ¾ lb. per day. Beside the grain ration each ewe received 2 lbs. per day of corn silage during the first week and from that time on they received 2½ lbs. per day. The silage was fed in troughs and the weight of the rejected food deducted. The latter was of very little importance.

The hay was fed at the rate of 2 lbs. per day. One half of this allowance was fed in an out door paddock to insure the ewes the necessary exercise when the weather was suitable.

TABLE I—*Grain consumed by each lot and number and condition of lambs.*

	No of ewes.	Pounds of grain consumed.	Pounds of silage consumed.	Pounds of hay consumed.	Pounds gain in live weight.	Period of gestation.	Number of singles, (1's), twins, (2's), triplets, (3's).	Number of barren ewes.	Total number of lambs.	Average weight of lambs.	Per cent of lambs strong.	Per cent of lambs medium.	Per cent of lambs weak.
Lot I......	10	455	1,795	1,540	94	146.6	6 (1's) 3 (2's) 1 (3's)	0	14	8.1	86%	6%	6%
Lot II.....	10	455	1,837	1,540	167	146.3	9 (2's) 1 (1's)	0	19	7.5	69	10	21
Lot III ..	10	455	1,862	1,540	127	145.7	5 (2's) 3 (1's)	2	13	8.3	91	9	......
Lot IV....	10	455	1,830	1,540	117	146.1	3 (2's) 6 (1's)	1	12	9.6	100	.....	......
Average ...	....	455	1,821	1,540	....	146.1	....	....	14	8.4	86.7	6.6	6.7

CONDITION OF THE EWES DURING THE EXPERIMENT.

The condition of the ewes throughout the experiment was satisfactory. The smallest gain obtained was 94 pounds made by Lot I. Lot II made the largest gain, amounting to 167 pounds and the four lots a total average gain of 146.1 pounds.

The ewes were pregnant with the exception of two. Another ewe having died of nodular disease during the last week of the

experiment has no lambs to her credit. The ration fed, cannot be blamed for causing the disease in question which is known to be contracted upon pasture.

COST OF RATIONS FED.

In order to compare the cost of the ration fed during this trial with the one fed in the previous trial and reported in the 19th Annual Report, it was necessary to use the same schedule of prices, upon which the cost was based in the latter trial. The prices quoted for the different feeds mentioned below were those prevailing on the Chicago market the winter of 1902–1903.

Oats	$30 00 per ton.
Bran	22 00 per ton.
Shelled Corn	24 00 per ton.
Corn silage	2 00 per ton.
Hay (Mixed)	10 00 per ton.

TABLE No. II.—*Amount of different feeds eaten and the amount of gain made by the ewes.*

	FED TWELVE WEEKS.				FED 8 WEEKS.
Number of Lot	Lot I.	Lot II.	Lot III.	Lot IV.	Lot V.
Number of trials	1	1	1	1	4
Number of ewes	12	12	12	12	10
Pounds shelled corn per head	42	....	....	....	15.15
Pounds whole oats per head	....	42	....	....	15.15
Pounds bran per head	....	....	42	....	15.15
Pounds dried brewers' grains per head	....	....	....	41.3	....
Amount of water per head for 2 weeks	68.5	71.6	75.7	80.0	....
Cost of grain per head	$.504	$.63	$.46	$.43	$.576
Cost of roughage per head	$1.05	$1.05	$1.05	$1.05	$.953
Gain in weight per head	19.5	19.25	17.2	20.3	12.6
Total cost of feed per head	$1.55	$1.68	$1.51	$1.48	$1.53
Cost of feed per head per week	$.13	$.14	$.125	$.123	$.139

Trials in in lots 1 2, 3 and 4 lasted 12 weeks. Trials in lot 5 lasted for 8 weeks only.

COMPARISON OF RESULTS OF THE TWO TRIALS.

The above table gives a comparison of the results obtained in this experiment and the previous trial where each lot received a single grain ration. In making the comparison, as each of the four lots was fed identical rations, we have considered each

lot fed as constituting a trial. The only point of difference in the comparison is that each lot fed the single grain ration contained 12 ewes while the lots that received the mixed grain ration each comprised 10 ewes. A glance at the table shows that there is practically no difference in the cost of the different rations fed. It cost $.139 per head per week, to maintain the ewes that were fed the mixed grain ration, while those of the lot fed whole oats cost at the rate of $.14 per head per week. The cost of feeding the ewes during both trials was somewhat higher than that reported in previous trials at this Station. This can be explained by the higher priced ruling for the grain at the time of this trial. The cost of feeding the breeding ewes for 12 weeks during the winter in the trials reported in the 17th and 18th Annual Reports amounted to about $.01 per day per ewe, but the prices used for the basis of that estimate were much lower.

TABLE III.—*Effects on the lambs of feeding various rations to pregnant ewes.*

Number of Lot	LOT I.	LOT II.	LOT III.	LOT IV.	LOT V.
	Shelled corn corn silage and mixed hay.	Whole oats, corn silage and mixed hay.	Bran, corn silage and mixed hay.	Dried brewers' grain, corn silage, mixed hay.	Shelled corn, whole oats and bran, equal parts.
Number of trials	1	1	1	1	4
Number of ewes	12	12	12	12	10
Period of gestation, days	146.7	146.2	146.3	145.6	146.1
Number of ewes having single lambs	3	3	4	4	4
Number of ewes having twin lambs	6	9	7	7	5
Number of ewes having triplets	2	0	1	1	1
Number of barren ewes	0	0	0	0	1
Total number of lambs	21	21	21	21	14
Total weight of lambs	163.6	170.9	161.5	170.9	117.0
Average weight of lambs	7.79	8.14	7.69	8.14	8.4
Per cent of lambs strong	69	83	58⅓	83	86.7
Per cent of lambs medium	17	17	33⅓	8½	6.6
Per cent of lambs weak	8	......	8⅓	......	6.7
Per cent of lambs dead	8	......	......	8½	......
Per cent increase	175	175	175	175	140
Per cent having good milk yield	33	25	33⅓	83	80

Lots 1-4 fed 12 weeks. Lot 5 fed only 11 weeks.

TABLE IV.—*The results of the condition of lambs and milk yield of the ewes according to breeds.*

BREED.	No. of ewes.	Ave. gestation period.	INCREASE.		Average weight.	STRENGTH OF LAMBS.			QUALITY OF EWES' MILK.		
			Number.	Per cent.		Per cent strong.	Per cent weak.	Per cent dead.	Per cent good.	Per cent fair.	Per cent poor.
		Days.									
Southdowns	6	145.5	8	133⅓	8.36	100	......	......	83⅓	16⅔	......
Oxfords	2	143.5	3	150	8.5	100	......	......	50	50	......
Merinos	1	150.0	1	100	8.6	100	......	......	100	......	......
Gr. Shropshires ...	15	145.9	23	153⅓	7.7	73.9	26.1	......	42.8	35.7	21.5
Gr. Southdowns ...	1	145.0	2	200	6.0	100	......	......	100	..	......
Dorsets	......	148.0	3	150	9.5	33⅓	66⅔	......	100	......	......
Montana grade....	1	......	2	200	7.4	100	..	......	......	......	100
Shrop. Merino	11	146.9	17	166⅔	8.6	81.8	18.2	......	81.8	18.2	......
Southdown-Shrop	1	......	None	......	......	......	......	......	......	......	......

[1] Died of nodular disease of the intestines.

EFFECT UPON THE LAMBS AND MILK SUPPLY OF EWES.

The feeding value of one ration compared with another, depends upon the increased number, strength and vitality of the lambs at birth and the character of the milk supply of the ewes at parturition, provided the cost of the various foods used is approximately the same.

The last table shows that the per cent of increase is not so great from the ewes that received the mixed grain ration which is 140 per cent, as from those of each lot receiving the single grain ration, which was 175 per cent. The percentage of stronger lambs, however, is greater in the former lot than in those receiving a single grain ration.

The milk supply of the ewes at the time of parturition was made note of, and graded as good, medium and poor. Sixty-four and eight-tenths per cent of the ewes on this trial graded as good. The lot fed brewers' grains in the previous trial contained 83 per cent that graded good, but those fed on the other single grain rations did not grade so high.

TABLE V.—*Table showing milking qualities of the ewes at parturition in both trials.*

Lots.	Good.		Medium.		Poor.	
	No.	Per cent.	No.	Per cent	No.	Per cent.
Lot I fed shelled corn	4	33	3	25	5	42
Lot II fed whole oats.......	3	25	5	42	4	33
Lot III fed bran............	4	33⅓	4	33⅓	4	33⅓
Lot IV fed brewers' grain ..	10	83	2	17	......	......
Two trials, 4 lots fed corn, oats and bran	24	64.8	9	24.3	4	10.8

TABLE VI.— *The dry matter and digestible nutrients in the daily rations of the lots in each trial.*

Lots.	Rations fed.	Dry matter.	Digestible Nutrients. Protein.	Carbohydrates.	Ether extract.	Nutritive ratio.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Lot I	½ lb. shelled corn.......... 2.5 lbs. corn silage .... 2 lbs. mixed hay	2.709	.1824	1.433	.0625	1:8.7
Lot II.... ..	½ lb. whole oats............ 2.5 lbs. corn silage... ...... 2 lbs. mixed hay............	2.709	.1885	1.33	.0625	1:7.8
Lot III......	½ lb. wheat bran........... 2.5 lbs. corn silage.......... 2 lbs. mixed hay	2.704	.2035	1.283	.055	1:7
Lot IV	½ lb. dried brewers' grains . 2.5 lbs corn silage .... 2 lbs. mixed hay	2.719	.2205	1.283	.0665	1:6.5
Av. 4 lots 2d trial....	.6 lbs. corn, bran and oats.. 2.5 lbs. corn silage .... 2 lbs. June grass hay.... ...	2.531	.1771	1.33	.08	1:8.4

THE EWES GROUPED ACCORDING TO BREEDS.

Grouping the ewes in this experiment according to breeds shows that the Dorsets and Southdowns excel the other breeds in milk supply at the time of parturition. There is considerable difference shown between the different breeds used in the trial as regards per cent of increase in strength and weight of the lambs at birth. The number of some of the breeds represented, however, is too small to show any definite results regarding these points.

The table showing the digestible nutrients and nutritive ratios of the rations fed, discloses very little difference in those particulars between the food fed the lots receiving a single grain ration and those fed a mixed grain ration. The ration fed during this experiment has a nutritive ratio of 1 : 8.4 which is somewhat wider than the nutritive ratio fed to Lot IV in the previous trial. That lot received dried brewers' grains and gave the best results and the cost of the ration and the effect upon the lamb crop correspond very closely. The results however do not show any decided advantage over those obtained when the ewes were fed a single grain ration.

SUMMARY.

The results of this experiment show: 1st. That a grain ration of 1 part corn, 1 part oats and 1 part bran, with corn silage and hay as roughage, is satisfactory for breeding ewes.

2nd. That a mixed grain ration composed of corn, oats and bran in the proportion fed in this trial is as economical as feeding one grain, such as shelled corn, whole oats, wheat bran or dried brewers' grains.

3rd. That when the milk supply is considered the grain ration of dried brewer's grains produced better results than the mixed ration fed in this experiment.

4th. That the average increase of lambs was greater in the four lots fed a single grain ration but the per cent of strong lambs was not so high.

5th. That corn silage with hay proved to be a good winter roughage ration for breeding ewes as in all trials previously made at this Station.

SOY BEAN SILAGE AS A FOOD FOR DAIRY COWS.

F. W. WOLL AND GEO. C. HUMPHREY.

During the last twelve years or more, the silo has become common on dairy farms in this country, and it is now in many districts considered an essential adjunct to the farm equipment. This is particularly true where Indian corn forms the main dependence for roughage for farm stock, and this crop is pre-eminently the American silage crop. On account of the heavy yield of food substances obtained from an acre of corn and the high feeding value of these, the importance of the corn plant to our farmers can hardly be over-rated.

It is generally agreed among dairymen, that succulent feeds have a beneficial influence on the production of milk, and we find, therefore, most silos among dairy farmers. Feeding experiments and practice agree in showing that a fair amount of nitrogenous food materials is required in order to obtain the best results in feeding dairy cows; in this particular, Indian corn, with all farm-grown crops except those of the legume family, is somewhat deficient, since we find only about one pound of digestible protein to every ten pounds of digestible carbohydrates and fat in shelled corn, and one pound of digestible protein to about every fifteen pounds of digestible carbohydrates and fat in either corn fodder or corn silage.

The first effort, so far as is known to the writers, to obtain a silage of a higher protein content than by the use of corn, was made by the present Commissioner of Agriculture of Canada, Professor Robertson, who recommended to place in the silo, instead of corn, the silage mixture that bears his name, composed of Indian corn, horse beans, and sunflower heads.

For various reasons, this mixture never met with favor among dairymen, and the method has now mainly historical interest.

In the south, methods of siloing leguminous crops, like cow peas and soy beans, with corn, have been adopted to some extent during late years; alternate loads of the two crops being either placed in the silo, or the crops are grown together in the field and harvested and siloed at the same time. This practice has also been tried to a limited extent by northern farmers, and reports are on record as to the practical experience thus obtained. As is usual, these reports differ considerably, however, and are often of such a character that no definite conclusions can be drawn as to the merits of this system of silage making. The method has several points in its favor, and has become the practice of some farmers, especially toward the south where the more nitrogenous crops can be grown to best advantage. Leguminous crops have also been recommended for the silo, and of these, at least clover and alfalfa can be successfully made into silage, which is greatly relished by farm stock. Other crops of this character that have been siloed to a limited extent, are soy beans, cow peas, and field peas.

For the past two years, the Department of Agronomy of this Station has conducted trials in growing soy beans on our experiment farm and elsewhere in the state, and has, in general, obtained promising results as regards the production of this crop, in sections where Indian corn will ripen. Under these conditions it was deemed desirable to investigtae the value of soy beans for siloing purposes, and about 1.7 acre of soy beans were accordingly placed in the silo in the University dairy barn as a trial, in the forenoon of Sept. 18, 1903. The beans at this time were full-sized and firm but were not ripe, the leaves and stems being still green. Fourteen tons of soy beans were siloed in all; the crop being cut with the mower and hauled to the silo without delay, where it was run through a silage cutter, and cut into about two-inch lengths. The soy beans were put on top of about 36 tons of corn, and in order to gradually accustom the stock to soy bean silage, a mixture of soy beans and corn, harvested together, were placed on top of the

soy beans. Twelve tons of corn and soy beans were siloed in all, in the afternoon of Sept. 18th, and the filling of the silo was then completed by placing somewhat over 100 tons of corn on top of the mixed corn and soy beans; the corn being cut in about one-quarter inch lengths.

The corn-soy bean mixture contained only a small proportion of soy beans; the seed was sown in a ratio of about 6:1, but the stand of soy beans was very light so that the silage obtained from this lot was largely corn silage with only occasional pieces of soy beans, and the flavor of the mixture was essentially that of corn silage. Samples were taken of the corn, the mixed corn and soy beans, and the soy beans, as the feeds went into the silo, and also once a week as the silage was being fed out. Moisture determinations were made in all the samples, and these were then united, and complete chemical analysis made of the composite samples. The results of these analyses are shown in the following table, which gives analyses of the sample of the feeds as placed into the silo and as taken out.

Composition of silage crops, in per cent.

	Green corn.	Corn and soy beans.	Soy beans.	Corn silage.	Corn-soy bean silage.	Soy bean silage.
Moisture	71.34	72.47	73.89	72.03	73.20	73.92
Protein	2.04	2.53	3.83	2.21	2.40	4.09
Fat	.84	.73	1.27	1.01	1.06	2.10
Crude fiber	6.18	6.15	6.91	5.88	5.89	7.94
N. free extr.	17.85	16.16	10.92	17.19	15.52	8.79
Ash	1.75	1.96	3.18	1.68	1.93	3.16
	100.00	100.00	100.00	100.00	100.00	100.00

We note that the soy beans contained more moisture than the corn or the corn-soy bean mixture, and the same relation is found in the corresponding kinds of silage; the protein content of the soy bean silage in the same way was considerably higher than that of the corn silage and somewhat higher than that of the corn-soy bean silage, while the non-nitrogenous components were lower in the soy bean silage than in the mixture and still lower than in the corn silage.

As no digestion experiments with corn-soy bean silage have been conducted, intermediate figures between the co-efficients for corn silage and for soy bean silage were used in calculating the digestible nutrients in the mixed silage. The sum of digestible substances in one hundred pounds of feed, was as follows, the fat being reduced to its carbohydrate equivalent in all cases: corn silage, 18.4 per cent, corn-soy bean silage, 16.3 per cent, and soy bean silage, 14.5 per cent. From a chemical-physiological point of view, we should therefore, expect to find the corn silage more valuable as a food for farm stock than an equal weight of soy bean silage. We shall discuss certain points of difference between the three kinds of silage after the results of the feeding experiments with milch cows have been presented, and shall then aim to show the value of these silage crops under northwestern conditions.

FEEDING EXPERIMENTS WITH MILCH COWS.

It was decided to obtain some evidence in regard to the practical feeding value of soy-bean silage for milch cows by feeding this silage in comparison with corn silage and corn-soy bean silage to our University dairy herd during the past spring. All the cows in the herd were fed corn silage as a part of the regular ration, up to March 23d, when the corn-soy bean silage was reached in our silo, and this silage was then fed for two weeks in the place of corn silage, after which time soy bean silage was fed to all the cows that wanted to eat it, so long as it lasted, viz., 2½ weeks. Corn silage was then again fed to the cows until May 18th, when they were let out on pasture. In the system of feeding practiced in our dairy herd, silage is always fed *ad libitum*, and it is aimed to give the cows as much of this feed as they will eat up clean. While all the cows seemed to relish the mixed silage nearly as well as the corn silage, three cows absolutely refused to eat the soy-bean silage when this was reached, and nearly all the cows ate this silage apparently with less relish than the corn, or mixed silage, and ate less of it than either of these other kinds of silage.

Hay and various concentrated feeds are fed to the different cows in the herd in such proportions and quantities as seems profitable, in view of the production of each cow, and the disposition which she makes of feeds of different nature. In the following table, the total amounts of different feeds consumed by the twenty-one cows in the herd, during the various periods of the experiment, are given, and also the average weights of the cows and their production of milk and butter fat. The percentage of fat is obtained by dividing the total amount of butter fat by the total amount of milk and multiplying the quotient by 100.

Feeding experiments with corn, corn-soy bean, and soy-bean silage for cows.

1904.	Hay.	Corn silage.	Soy-bean silage.	Wheat bran.	Oats.	Corn.	Cotton seed meal.	Oil meal.	Dist. grains.	Live weight.	Milk.	Per cent. fat.	Lbs. fat.
Corn silage:													
March 9-16 ...	854	6608	......	571.8	29.7	15.3	268.3	36.9	494.8	1103	4040.0	.....	162.63
March 16-23...	833	6664	.....	592.4	9.6	3.4	282.1	6.4	588 8	1107	4014.4	.....	160.88
Average... .	843.5	6636	......	582.1	19.7	9.3	275.2	21.7[2]	541.8	1105	*4027.2*	4.01	*161.74*
Corn-soy bean silage:													
March 23-30. .	833	7497	......	584.8	25.2	8.4	260.4	16.8	560.0	1116	3852.3	.....	164.05
Mar.30-Apr. 6.	812	6580	......	605.6	....	.....	250.4	.....	540.4	1129	3834.8	.....	163.24
Average.....	822.2	7038	......	595.2	12.6	4.2	255.4	8.4	550.2	1122	*3843.5*	4.27	*163.64*
Soy-bean silage:													
April 6-13.....	805	......	5000	619.0	22.1	7.4	255.2	14.7	537.6	1090	3462.4	.....	147.50
Apr. 13-20	840	......	4779	615.6	19.6	4.9	256.4	4.7	543.2	1085	3331.7	.....	139.99
Average. . ..	822.5	...	4888.5	617.3	20.8	6.1	255.8	9.7	540.4	1088	*3397.0*	4.23	*143.74*
Corn silage-soy bean silage:													
April 20-27	830	2694	2429	616.0	19.6	4.9	256.2	4.9	554.4	1095	*3484.6*	4.00	*140.06*
Corn silage:													
April 27-May 4	805	5712	......	620.2	22.	7.4	245.0	14.7	554.4	1101	3633.8	.....	147.64
May 4-11	805	5672	......	592.2	22.	7.4	231.3	14.7	532.0	1095	3517.6	.....	137.81
Average.....	805	5692	... ..	606.2	22.	7.4	238.1	14.7	543.2	1098	*3575.7*	3.96	*142.82*
Corn silage:													
May 11-18	805	5936	......	569.6	22.	7.4	222.6	14.7	550.6	1116	*3663.5*	3.85	*141.03*
Pasture:													
May 18-25	230	2536	......	336.6	13.8	4.6	142.8	9.2	352.2	1106	3563.4	.....	145.7
May 25-June 1.	......	......	......	264.4	12.6	4.2	105.0	44.8	244.8	1106	3803.1	.....	153.65
Average.	115	1268	.....	300.5	13.4	4.4	123.9	27.0	398.5	1106	*3683.2*	4.06	*149.67*

[1] 7.2 lbs. gluten feed in addition.
[2] 3.6 lbs. gluten feed in addition.

The decrease in the consumption of silage, and in the production of milk and butter fat in the case of all the cows, without an exception, in going from the corn-soy bean silage to the soy-bean silage was very striking, and it was found necessary to increase the grain allowance to a number of the cows, in order to prevent a large shrinkage in production. The table given below shows the average daily feed consumed and the production per cow for each period of the experiment.

Average daily rations fed to cows, with production, in pounds.

Period.	Hay.	Silage.		Wheat bran.	Oats.	Corn.	Cotton seed meal.	Distillery grains.	Total grain.	Production of	
		Corn.	Soy bean.							Milk.	Fat.
Corn silage, Mar. 9–23	5.5	45.2	......	4.0	.1	.1	1.9	3.7	9.9	27.4	1.10
Corn-soy bean silage, Mar. 23–Apr. 6	5.6	47.9	....	4.1	.1	.. ..	1.7	3.7	9.7	26.1	1.11
Soy bean silage, Apr. 6–20	5.6	......	33.2	4.2	.1	......	1.7	3.7	10.2	23.1	.98
Corn silage, soy bean silage, Apr. 20–27	5.6	18.3	16.5	4.2	.1	......	1.7	3.8	9.9	23.7	.95
Corn silage, April 27–May 11	5.5	38.7	.....	4.1	.1	......	1.6	3.7	9.7	24.3	.97

It is evident from the results of this experiment, that soy-bean silage is not as valuable a feed for milch cows as corn silage, or as corn-soy bean silage, when the immediate productive capacity of the feeds alone are considered. There are other reasons, however, and more cogent ones, why this silage cannot be recommended to the dairy farmer; we will now briefly discuss these.

First, the lower yield of food substances obtained from an acre of soy beans than from an acre of corn; in last year's experiments with soy beans, in a season very favorable to this crop, a yield of green substance, at the rate of 16,950 pounds per acre was obtained on the University farm; in the same season, the corn yielded at the rate of 30,400 pounds per acre. According to chemical analyses made, the soy beans contained 4,426 pounds of dry matter per acre, and the corn 8,713 pounds per acre, a difference of nearly 100 per cent in favor of the corn.

Second, The rank odor of the soy-bean silage is most unpleasant to man and beast alike. Many of the cows at first refused to eat the silage, or ate only a little without any relish, and it took most cows about a week to become accustomed to it. A marked decrease in the milk yield followed the change from corn to soy-bean silage, as indicated in the data given in the summary table. The soy-bean silage was not eaten up clean by any of the cows, coarse pieces of stems being left in the mangers after each feeding. It was found, by repeated weighings, that these refuse stems made up about 10 per cent of the total amount of silage given the cows. It is possible that the refuse might be somewhat reduced in amount by shredding the beans or cutting them into shorter pieces, but owing to the tough, woody nature of the soy-bean stems, it is not to be expected that the waste can ever be entirely utilized by stock.

A *third* and vital objection to soy-bean silage to dairy cows is the effect of this silage on the quality of the milk, butter and cheese. Soon after we began feeding soy-bean silage to our dairy herd, complaints were made by the University creamery, where the cream separated at the dairy barn is hauled, that this had a very objectionable flavor; it was found that this flavor would contaminate a large quantity of cream, and that the butter made from the cream would, likewise, possess the same flavor and render it unfit for a discriminating trade. It was also found, that the curd made from soy-bean-silage milk showed a gassy fermentation, and possessed a sweetish, disagreeable odor when pressed between the fingers. Milk produced when soy-bean silage was fed, was submitted to three judges for criticism, with a number of other samples of milk of faultless flavor. Without an exception, the soy-bean-silage milk was discovered and was pronounced of poor flavor by all the judges; we are confident, therefore, that the milk produced on soy-bean silage could not be retailed without causing considerable annoyance to the dairyman on this account.

In our system of feeding silage, this is always fed *after* milking time; the cows are kept in a modern, sanitary, well-

ventilated and lighted stable; the mangers are always cleaned out before the cows are milked, and the milk is removed from the stable air as soon as drawn, and weighed. On basis of our experience with soy-bean silage, we do not believe, therefore, that a satisfactory grade of milk or other dairy products can be made when this silage is fed to the cows.

It may be added here for the sake of completeness, that breeding ewes, to which soy-bean silage was fed last winter, objected to the silage for several days,—as did the shepherd, although with less emphasis,— but that the ewes took kindly to it after this time, and in the judgment of the shepherd, apparently improved in condition during the following two weeks while this silage was fed.

The objections to soy-bean silage, which have been stated in the preceding, would not, in our experience, apply to the mixed corn-soy bean silage. As has been already remarked, this mixed silage was eaten by the cows with apparent relish, and no deleterious influence was observed as regards the quality of the milk or cream produced when this silage was fed, which, it should be remembered, contained a relatively small proportion of soy beans. According to our present experience, we may, therefore, consider this silage mixture an improvement on corn silage, in so far as it furnishes a succulent, palatable feed, containing a somewhat larger proportion of nitrogenous food materials than is found in pure corn silage.

View of Dairy Herd, University of Wisconsin, 1904.

THE UNIVERSITY DAIRY HERD, 1903-1904.

GEO. C. HUMPHREY AND F. W. WOLL.

During the past year, the feed consumption and the production of milk and butter fat by the cows in the University dairy herd, have been determined in the same manner as during the previous four years; the investigation here reported, is a continuation of the work done during this period, which is described in bulletin 102 of our Station, Studies in Milk Production, by Professors Carlyle and Woll.*

The average production of thirty-eight cows, which furnished the data for the records given in this bulletin, and which covered a period of one to four years for the different cows, was found to be 7,340 pounds of milk and 307 pounds of butter fat, equivalent to 370 pounds of butter per head, annually. Twenty-two of the cows produced more than 300 pounds of butter fat per year, on the average, and twenty-five yielded a profit of $40.00 or more per year over the cost of the feed eaten. Of the cows in the herd during the years considered in the bulletin, fourteen were either two or three-year olds when placed in the working herd, and if these be excluded, the average production of the herd will, of course, be correspondingly increased.

The exact composition of the rations fed to the cows could only be determined during the winter months, since the cows were pastured in summer. The average ration fed to the cows during the winters 1898–1903, contained 23.72 pounds dry matter, 1.85 pounds digestible protein, and 14.11 pounds

*This bulletin is still available and copies will be mailed free upon request so long as the supply lasts.

digestible carbohydrates and fat, its nutritive ratio being 1:7.6. While this ration supplies a sufficient quantity of dry matter, and even an excess of digestible carbohydrates and fat, according to the Wolff or Wolff-Lehmann feeding standards for dairy cows, it is considerably below these standards in digestible protein, and its nutritive ratio is, therefore, wide, compared with the German standards. Only ten out of a total number of thirty-three cows required more than two pounds of digestible protein in their average daily winter rations, under our system of feeding for a large and economical production, and only four cows received rations of a nutritive ratio narrower than 1:7.0.

In view of these facts, it might be argued that the production of our cows would have been still higher than it was, if the system of feeding followed had adhered more closely to the accepted feeding standards for dairy cows, and rations had been fed containing more digestible protein and of a narrower nutritive ratio. To obtain data on this point, it was decided to make the change suggested in the system of feeding during the past year; our herd, therefore, received rations of somewhat narrower nutritive ratios beginning with the winter period last year, than were fed during the periods covered by bulletin 102. As before, the system of feeding followed was to give each cow as much concentrated feed as has been found necessary for a maximum production of milk and butter fat, without causing a gain in live weight, and as much roughage as would be eaten up clean.

The regular grain mixture fed during the past year was made up of wheat bran, distillers' grains, and cotton seed meal, in the proportions of 2:2:1. It was estimated that this mixture would have a nutritive ratio of about 1:2 against 1:4.0 or 3.6 for the grain mixtures fed during the previous years (Bulletin 102, page 74). When the chemical analyses of the feeds fed to the herd and sampled during the past year, were completed, it was found, however, that the feeds were less nitrogenous than anticipated, and the nutritive ratio of the mixture fed was 1:2.4. This rendered the ratio of the rations fed during the year somewhat wider than anticipated, but they

were, on the whole, considerably narrower than during the preceding years, as will be seen from the tables submitted below. The more nitrogenous feeding was not commenced until at the beginning of the winter period, and only half of the year considered in this report differs, therefore, from previous years, as regards the character of the rations fed.

COWS IN THE DAIRY HERD, 1903-1904.

The number of cows in the dairy herd has varied during the past year, owing to additions being made through purchase, and a few sales; at the close of the year here considered, the herd consisted of thirty-eight cows and five bulls. Of the latter, three were loaned by breeders for temporary use in our herd. The various breeds were represented by the following number of cows:

	Pure-Breds.	Grades.
Jerseys	6	1
Guernseys	8	3
Holsteins	6	1
Shorthorns	5	2
Red Polls	3	1
Brown Swiss	2	..

Through the liberality of the state legislature of 1903, an appropriation of $10,000 was made for the purchase of purebred stock for the University farm; about $4,000 of this amount was set apart for the dairy herd. During the past year, the following numbers of pure-bred cows of the various breeds have been added to the herd, viz., three Jerseys, five Guernseys, two Shorthorns, two Red Polls, and two Brown Swiss. It is planned to place in the herd, in the near future, representatives of the Ayrshire breed of cattle, and of bulls of various breeds, from the amount of money still at our disposal for the purchase of dairy animals. A number of grade animals were disposed of during the year, and those remaining will be gradually replaced by registered animals, as opportunity offers to secure such. It is our aim to keep in the future, a dairy herd composed of nothing but pure-bred animals, that shall be typical representatives of their respective breeds, and shall be large and economical producers. Such a herd

will furnish invaluable material for class-room instruction for our agricultural and dairy students, as well as for investigation of problems relating to dairy husbandry.

Great difficulty was experienced in obtaining animals that possessed the characteristics of their respective breeds in a marked degree, and at the same time, gave promise of reaching a high standard of economic production. The future will determine in how far our efforts to secure these two requirements have been successful, in the case of the various cows added to the herd during the past year.

Of the thirty-eight cows in the herd, at the close of the year 1903–04, twenty-one have finished a year's record since the publication of bulletin 102, and their production and food consumption for this year will be found in the tables on the following pages. In addition to this number, eight cows completed records for the last winter period, which supplies data for studying the relation of food to dairy production. The following table gives a complete list of both the new cows and the older ones which have finished a year's record since the publication of bulletin 102.

List of cows in University herd, 1903–4.

Name of Cows.	Breed.	Date of birth.	Dates of Calving. 1898.	1899.	1900.	1901.	1902.	1903.	1904.
Pauline	Gr. Sh	1894	July 7	Aug. 6	May 19	Dec. 1	Dec. 29	....	....
Alma	H	Mar. 23, '96	....	Aug. 13	Sep. 12	Aug. 24	Dec. 14	....	Jan. 20
Bessie	Gr. G.	1892	Sep 1	Oct. 13	Oct. 24	Aug. 26	Oct. 18	....	Mar. 4
Reba	Gr. J.	1897	....	May 10	Apr. 2	Feb. 10	Feb. 25	Feb. 27	Apr. 11
Campbell	Sh.	Nov. 10, '93	....	Dec. 6	Dec. 13	....	Jan. 13	May 5	July 24
Donation	Gr. H.	1898	....	....	Nov. 30	Dec. 29	Dec. 25	Dec. 29	....
McGoech	H.	1899	....	....	....	Jan. 19	Feb. 11	Feb. 7	July 25
Laura	J.	Jan 20, '95	....	....	....	Spring.	Aug. 6	July 26	....
Joe	H.	Aug 13, '99	....	....	....	Aug. 6	Nov. 5	Dec. 1	....
Brownie	J.	1897	....	....	....	Sep. 13	Dec. 29	Dec. 14	....
June	Sh.	Oct. 9, '99	....	....	....	Sep. 14	Dec. 27	....	Jan. 7
Lady	Gr R. P	1898	....	....	....	Aug. 7	Oct. 13	Dec. 27	....
Dorine	Gr. G.	1900	....	....	....	....	Jan. 13	Mar. 12	Mar. 31
Muriel	Gr. G.	1900	....	....	....	....	Mar. 18	Apr. 1	Apr. 3
College Rose	Sh.	Oct. 18, '00	....	....	....	....	Nov. 14	Dec. 4	....
Jennie	G.	Jan. 1, '01	....	....	....	....	....	Feb. 27	Apr. 2
Maggie	H.	Mar. 25, '98	....	....	....	....	....	Mar. 19	Aug. 31
Lucy Miller	J.	Mar. 25, '92	....	....	....	Fall.	....	Sep. 25	....
Double Time	J.	Mar 25, '99	....	....	....	....	....	Mar. 16	....
Maud	Gr. Sh.	July 27 '98	Jun. 14	Sept. 6	Dec. 18	Nov. 30	....	Feb. 1	Aug. 25
Flashlight	G.	Oct. 25, '00	....	....	....	....	....	Apr. 6	May 1
Josephine	H.	Aug. 6 '01	....	....	....	....	....	Sep. 18	....
Julia	Sh.	Nov. 11, '96	....	....	....	....	....	Oct. 16	....
Topsy	R. P.	Aug. 7, '98	....	....	....	....	....	Sum'er	....
Artis	H.	Sep. 13 '01	....	....	....	....	....	Dec. 4	....
Marcella	J.	Nov. 17, '99	....	....	....	....	....	Aug.	Sep. 11
Floradora	G.	June 1, '01	....	....	....	....	....	May	....
Celia	R. P.	June 29, '01	....	....	....	....	....	Nov. 24	....
Lina	R. P.	Mar. 1, '95	....	....	....	....	....	Spring.	Apr. 26

We give the following brief descriptions, accompanied with photographs, of the cows added to the herd during the past year, whose records for a full year or for the winter period are given and discussed in this report.

DESCRIPTION OF COWS ADDED TO THE DAIRY HERD DURING 1903–04.

Lucy Miller.—Jersey, dropped March 25, 1892, bred by Hon. G. E. Bryant, Madison, Wis., and purchased of F. C. Warren, Fox Lake, Wis., in the spring of 1902. Lucy Miller represents a large, strong type of the Jersey breed. Considering that she is now 12 years of age, it is remarkable to note how she has retained her straight back and general vigorous tendency.

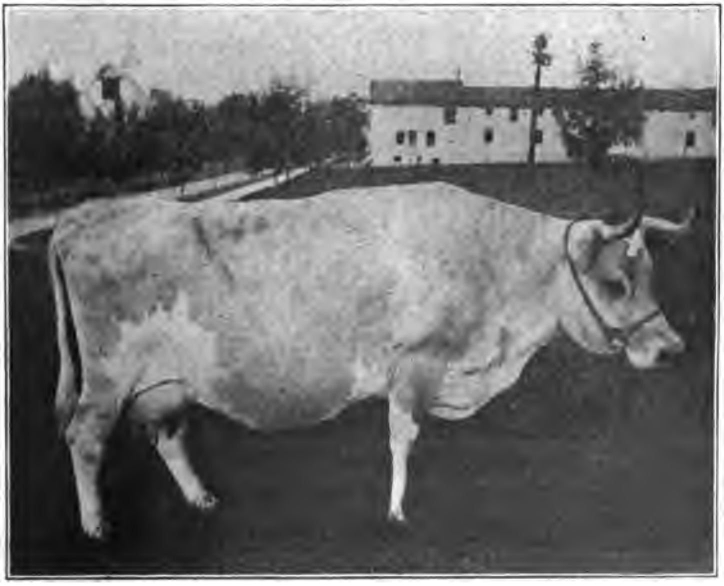


FIG. 7.—Lucy Miller (Jersey).

Few animals, after having produced for so many years, show the vitality she still maintains. She may be criticised as being somewhat coarse in the head, neck and shoulders. She has, however, an excellent spring of rib, and a deep body, which give her capacity as a feeder, and her milk organs are such that she may be considered an excellent type of a dairy

cow. From the rear quarters, she is broad and roomy. Her udder hangs well and is of good quality, but slightly deficient in the development of the fore-quarters. She has a remarkable development of milk veins, long, branchy and tortuous, being more prominent than those of any other cow in the herd. During the six months after freshening, at the University, she made a record of 5,561 lbs. of milk and 285.0 lbs. of butter fat, but her age and the manner in which she was fed, prevented her being an economical producer for the year (see p. 95).

FIG. 8.—Double Time (Jersey).

Double Time.—Jersey, bred by F. C. Warren, Fox Lake, Wis., purchased by the University in March, 1903. She was dropped March 25th, 1899, being four years of age when she came into the possession of the University. She is a very attractive Jersey cow because of her solid light color, clean-cut characteristic Jersey head, and general conformation indicating her rich milking qualities. She is criticised as being rather fleshy for a typical dairy cow, but she will be apt to improve, however, in this respect as she grows older. She is gradually

developing size and capacity, together with an improvement in her milk organs which gives promise of her becoming a credit to her breed.

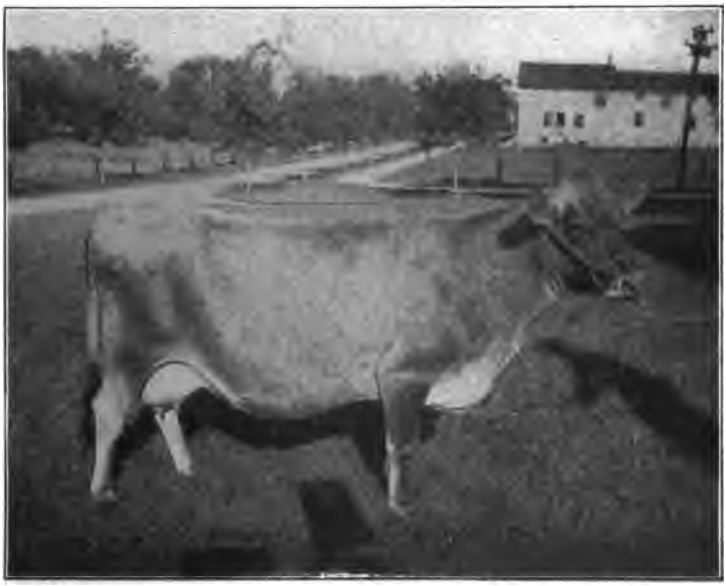


FIG. 9.—Marcella (Jersey).

Marcella.—Jersey, calved March 17, 1899; bred by Hugh Keenan, Quaker City, Ohio, and purchased by the University from A. R. Collins, Xenia, Ohio, in November, 1903. She is a medium-sized Jersey cow, showing a strong dairy temperament, having a long, wedge-shaped body. She is rather long in the neck, and narrow through the shoulders, which offers the general criticism that she is a little too narrow throughout her entire body for a typical dairy cow. She has an udder of excellent texture and quality. If the forequarters were a little better developed, her udder would be beyond criticism. Her milk veins are fairly well developed.

Jennie.—Guernsey, dropped Jan. 1, 1901; bred by Clayton C. Taylor, Lawton Station, N. Y., and purchased by the University in October, 1901. While she is a promising heifer, she has shown a tendency to convert her surplus food into

flesh. She may be criticised as being somewhat coarse about the head and body, and has never grown to the size of a typical Guernsey cow. Not only has her dairy performance been hindered on account of her size and tendency to put on flesh, but she has of late been subject to rheumatism which has given her a great deal of trouble.

FIG. 10.—Jennie (Guernsey).

Flashlight.—Guernsey, dropped October 25, 1900; bred by Clayton C. Taylor, Lawton Station, N. Y., from whom she was purchased by the University, in the fall of 1901. She was a promising heifer and made a satisfactory record for the year in spite of the fact that one quarter of her udder failed to perform its functions. She has a fine head and neck, but is undersized for a typical Guernsey and will not be apt to improve in this respect. By careful manipulation throughout her milking period of the last year, and since she dropped her second calf, the deficient quarter of her udder has been developed until at the present time it yields a normal amount of milk and cannot be criticised from the standpoint of

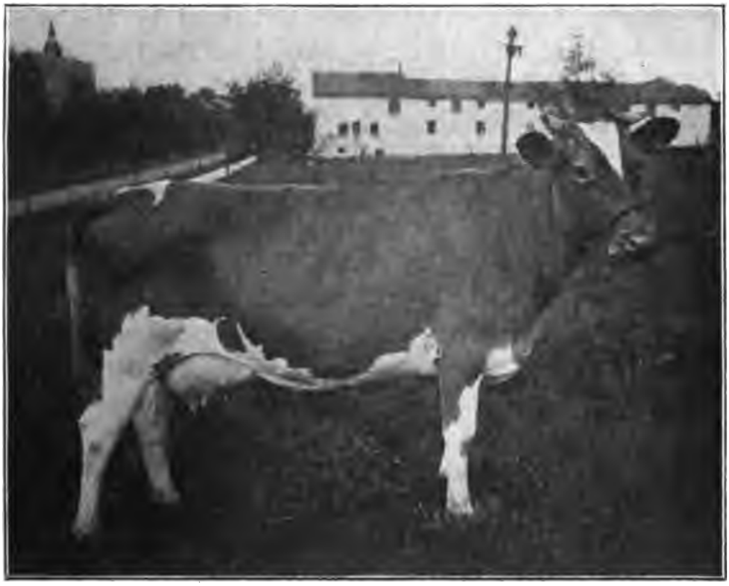


FIG. 11.—Flashlight (Guernsey).

function. As viewed in the picture, however, it shows a lack of development which spoils the symmetry of her udder as a whole.

FIG. 12.—Floradora (Guernsey).

Floradora.—Guernsey, two years old; bred by McCormick & Edgerly, Pataskala, Ohio; purchased by the University of Wm. Conley, Cedarville, Ohio, in the fall of 1903. She is a fine type of her breed, as a heifer, and is making a growth and development that gives promise of her becoming an excellent cow. Her present form appears to be a little rangy, but she has a long, fairly deep body, splendid head and neck, and a very symmetrical udder, with a good development of milk veins. Her udder is of the finest quality, and her teats are good-sized and well placed. Her disposition might be criticised as being sluggish, but her feeding qualities do not bear out this criticism. She freshened in the spring of 1903 before two years of age, and had not been bred again when she came into the University herd. She has proved herself a persistent and satisfactory producer during the time she has been in our herd.

FIG. 13.—Maggie Morris (Holstein).

Maggie Morris.—Holstein; calved March 25th, 1898 and bred by J. N. Hutchinson, Randolph, Wis., purchased by the

University in December, 1902. She represents the type of a strong and large dairy cow, being an excellent producer. Her head might show more refinement, but little criticism can be made of her form and size. She has a remarkable spring of rib, with plenty of capacity. The picture shows her udder in a relaxed condition, as she was not milking at the time it was taken. When she is in milk, her udder shows unusually well. She is a good feeder and a persistent milker.

FIG. 14.—Artis (Holstein).

Artis.—Holstein, dropped Sept. 13, 1901; bred by the University; dam, Chloe Artis Netherland 4th, at one time a very profitable cow in the University herd. Artis is a strong, vigorous heifer, but has a tendency to carry a little too much flesh. Her head and neck show plenty of refinement, while her body has a slight beefy appearance. Although her udder is not symmetrical and her teats are small, she has proved to be a persistent and profitable milker. For a Hol-

stein cow, she is a high tester; she was admitted to the Advanced Register when two years of age, on a weekly official test of 10.846 lbs. of butter fat.

FIG. 15.—Josephine (Holstein).

Josephine.—Holstein, dropped August 6th, 1901. Bred at the University farm, out of the Holstein cow, Joe; she is a granddaughter of our cow, Alma. In type, she resembles her dam and granddam with the exception that she stands higher and has a somewhat larger and coarser body. Her narrow chest would indicate a lack of constitution. Her udder shows to a disadvantage in the cut, owing to the fact that she had been milked nearly a year when her photograph was taken. For a heifer, she has a well developed udder, well quartered, with good-sized teats. She has an official weekly record of 9.65 pounds of butter fat, shortly after freshening in 1903.

June.—Shorthorn, five years old; bred at the University farm out of the Shorthorn cow, Jane, formerly one of the cows in our dairy herd. In spite of the fact that she was somewhat weak and delicate as a heifer, she has developed into

FIG. 16.—June (Shorthorn).

one of the large, strong cows of the herd, and, in fact, is too much of a beef animal to be a satisfactory milker. Her

FIG. 17.—College Rose (Shorthorn).

udder is small and is especially deficient in the rear quarters. She has a maximum yearly record of 7,319 pounds of milk and 275 pounds of butter fat; this is a fair record for a dual-purpose cow, but is below that of other Shorthorns in the herd.

College Rose.—Shorthorn, calved October 18th, 1900, and bred by the University out of the cow, Jane. She is of medium size and is naturally inclined to be thin in flesh. The accompanying picture shows her udder rather small, due to the fact that she was nearly dry when the picture was taken. For a young cow, she has a well-developed and evenly balanced udder. As yet, she has proved to be only an average feeder, but promises to develop more capacity as she grows older.

FIG. 18.—Julia (Shorthorn).

Julia.—Shorthorn, dropped March 11th, 1896; bred by R. A. Morley & Co., Baraboo, Wis., and purchased by the University, November, 1903, of John Herr, Merrimac, Wis.

Julia is a large, strong-bodied cow of the dual-purpose type. Her body is deep, having plenty of width, level on the back, with prominent hooks. Little fault can be found with her udder, as it is symmetrical, with evenly-placed teats, and good development of milk veins. During the time she has been in the herd, she has proved to be a persistent milker.

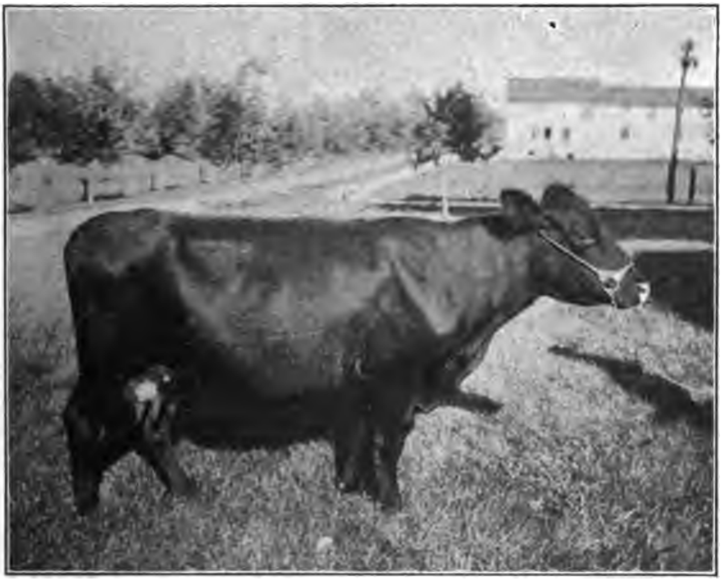


FIG. 19.—Lina (Red Poll).

Lina.—Red Poll, calved March 1, 1895; bred by P. T. Hendrickson, Coggon, Ia., and purchased by the University in the fall of 1903. Lina is a small cow with less quality and constitution than is characteristic of her breed. She is of a nervous temperament and carries no extra flesh. Although rather coarse in the head and neck, she has more of a dairy form than either of the following cows. She is a dainty feeder. Lina has an udder of good quality with evenly placed

teats. The percentage of butter fat in her milk is somewhat low for a Red Poll, often testing below three and a half per cent for her weekly test.

FIG. 20.—Topsy (Red Poll).

Topsy.—Red Poll, dropped August 7, 1898; bred by P. T. Hendrickson, Coggon, Ia., and purchased by the University in the fall of 1903, with the assistance of Hon. J. W. Martin, of Richland City, Wis., as applies also to the preceding cow. She represents a good type of Red Polled cow. She is of medium size, has a smooth body and is more rangy than the following cow and has less of a tendency to put on flesh. While her udder might be better developed and extend farther forward, it is of good quality and she has proved herself to be a fairly persistent milker.

Celia.—Red Poll, dropped June 29, 1901; bred by S. McGilkeria & Son, Fairfield, Neb., and purchased by the University in the fall of 1903 of Hon. J. W. Martin, Ricland City, Wis. She is rather small in size, being of the more blocky type of the Red Polls. She has a typical Red Poll head, and is an attractive representation of her breed. When highly fed she has, however, a tendency to put on flesh rather than to increase in

her flow of milk. Her beefy tendency is not conducive to a persistent milk production. She is deficient in the fore udder and her milk veins show only a fair development.

FIG. 21.—Cella (Red Poll).

CONDITION AND MANAGEMENT OF THE HERD.

The general health of the herd during the past year has been exceptionally good. No cases of milk fever, garget or other diseases that are common to dairy herd, have occured since the publication of our last report. The cows Flashlight, McGeoch, Jennie and Marcella were off feed for brief periods for various reasons, but in no case was their year's production appreciably affected by the temporary indisposition. Bessie suffered from an injured knee during March and April, which seriously affected her appetite and decreased her production to a considerable extent, both for the winter period and for the year.

The care of the herd was in the hands of Mr. J. R. Danks, up to April 1, 1904, when Mr. C. J. McComb succeeded him as herdsman. The favorable showing which the herd has been

able to make during the last year, is no doubt due to a large extent to the painstaking, intelligent, and efficient work done by these gentlemen. Acknowledgement is also due to Messrs. W. B. Richards and J. G. Fuller, assistants in animal husbandry during the past year and the present one, respectively, for assistance in the compilation of the herd records given in this report.

The care and management of the herd, and the system of feeding followed during the past year, were similar to those of previous years, and described in our bulletin 102, to which reference is here made for information on these points, as well as in regard to the method of obtaining records for the production of milk and butter fat, and the cost of feed and value of products. The following prices of feeds and products adopted in last years' compilations, which we have made use of, are reproduced here for ready reference.

SCHEDULE OF PRICES OF FEEDS AND PRODUCTS:

Hay, per hundred pounds	$0 40
Corn silage, per hundred pounds	12½
Soiling crops, per hundred pounds	7½
Roots, per hundred pounds	15
Corn fodder, per hundred pounds	15
Pasture, per month	1 50
Wheat bran, per hundred pounds	60
Oats, per hundred pounds	80
Corn, per hundred pounds	70
Oil meal, per hundred pounds	1 20
Gluten meal, per hundred pounds	1 10
Gluten feed, per hundred pounds	90
Dried brewers' grains, per hundred pounds	80
Distillers' grains, per hundred pounds	1 10
Cotton seed meal, per hundred pounds	1 30
Butter, per pound	20
Skim milk, per hundred pounds	15

HERD RECORDS, 1903–04.

The amounts of the various kinds of feeding stuffs consumed by the cows in our dairy herd that completed a year's record prior to May 18, 1904, since the last period for which data are published in bulletin 102, are shown in the following tables, with the production of milk and butter fat of the cows,

the value of the products, the cost of the feed eaten, and the net profit returned, over and above cost of feed, together with other data that have a bearing on the production of the cows. For the sake of comparison, similar average data for the previous periods during which the cows have been in our herd, are also given, with general averages in each case for the entire periods, including the past year. In the case of six cows, whose previously published records ended with Nov. 15, 1902, the year here reported covers the period from this date to Nov. 18, 1903.

The cows have been placed in the tables in the order of decreasing profits returned in the value of products, over and above cost of feed during last year. This order would only be changed in a few cases, if the average net profits for the entire period were used as a basis of placing the cows. instead of the figures for last year only.

Feed consumed per cow per year, in pounds.

Cow.	Year.	Hay.	Silage.	Soiling.	Roots.	Wheat bran.	Oats.	Corn.	Oil meal.	Gluten meal.	Gluten feed.	Dist. grains.	Cotton seed meal.	Brewers grains.	Skim milk.
Lady..........	'03-'04	1209	8809	5149	1883	1012.1	266.2	30.0	329.5	....	330.6	394.4	257.4	....	....
Average....	'01-'03	1387	13551	2272	1803	951.	642.	546.	376.	160.	....	....	....	80.	....
Average....	'01-'04	1327	11970	3231	1829	971.7	516.7	375.6	360.5	106.6	110.2	131.4	85.8	53.0	....
Maggie........	'03-'04	1118	11161	2062	.. .	1114.	84.0	28.0	56.0	....	56.0	560.0	25.20	....	....
Maud..........	'02-'03	890	10575	2062	....	946.	19.6	42.0	206.8	....	148.4	....	....	....	....
Average....	'98-'02	1131	9287	3534	365	851.0	661.	585.	217.	67.	....	....	....	14.	....
Average....	'98-'03	1082	9544	3239	292	869.5	572.8	476.6	215.2	107.5	29.6	....	....	11.2	....
Pauline	'02-'03	886	10674	2201	505	806.	255.	156.	157.	157.	....	....	....	....	....
Average....	'98-'02	991	8561	3379	774	764.	455.	330.	164.	25.	....	....	....	77.	....
Average....	'98-'03	970	8983	3143	720	772.	415.	295.	162.	51.	....	....	....	61.	....
Alma..........	'03-'04	978	8179	2062	820	822.	308.0	145.7	235.1	141.0	113.0	316.8	209.2	....	....
Average....	'99-'03	1078	9279	3322	639	1061.4	843.2	682.5	330.6	92.0	....	....	....	60.	3305
Average ...	'99-'04	1058	9059	3070	675	933.	776.1	575.1	311.5	101.5	22.6	63.4	41.8	48.3	2640
Donation......	'03-'04	955	7151	2062	579	1111.	37.8	6.3	67.2	.	37.8	549.0	245.0	....	....
Average....	'01-'03	1291	9396	3383	544	692.1	522.2	370.2	177.1	91.4	....	....	....	164.5	....
Average....	'01-'04	1512	8647	2942	555	831.	361.0	248.8	140.5	61.0	12.6	183.0	81.6	109.2	....
Joe	'03-'04	1064	9829	2006	2356	1313.	252.1	245.1	260.8	....	14.0	408.0	319.2	....	....
Average....	'02-'03	904	7161	3203	3965	1109.	364.0	503.1	305.7	182.6	....	....	....	29.4	....
Average....	'02-04	984	8495	2604	3160	1211.	308.0	374.0	283.0	91.3	7.0	204.0	159.6	14.7	....
Campbell	'02-'03	856	8615	1 32	....	821.2	223.2	166.2	131.2	22.4	109.8	....	....	....	..
Average....	'99-'02	1046	8421	3277	226	679.0	464.0	378.0	180.	23.	....	....	....	37.	....
Average....	'99-'03	998	8469	2866	169	714.7	403.7	324.8	168.8	22.9	27.4	....	....	28.	....
Double Time..	'03-'04	1041	9686	1894	....	937.2	183.0	91.5	119.5	...	183.0	571.2	257.6	....	....
Bessie.........	'02-'02	1065	4954	....	....	907.2	44.8	67.2	32.2	....	11.2	260.4	90.0	....	....
Average....	'98-'02	1000	789	3052	734	769.1	652.2	404.0	245.0	107.5	....	....	....	56.7	....
Average....	'98-'03	1013	7303	2441	587	676.6	530.6	336.6	202.6	85.0	2.6	52.1	18.0	45.3	....
Muriel.........	'03-'04	1099	7902	1635	....	849.2	95.2	36.4	71.4	....	61.6	271.6	89.8	....	....
Average....	'02-'03	825	5888	3080	490	605.6	229.4	298.4	129.5	128.3	....	....	....	86.4	....
Average....	'02-'04	961	6895	2357	245	727.4	162.3	167.4	100.4	64.1	30.8	135.8	44.9	43.2	....
Reba	'03-'04	1134	8117	2054	...	307.2	64.8	27.4	70.0	....	49.8	412.0	92.4	....	....
Average ..	'99-'03	915	7433	3141	364	625.5	374.1	284.4	144.8	53.9	....	....	....	20.3	105
Average. ..	'99-'04	958	7569	2923	291	654.4	312.2	233.0	115.8	43.0	9.9	82.4	18.5	16.2	85
Laura	'03-'04	[illegible]	8658	1719	....	1270.	126.0	63.0	107.8	....	135.8	464.8	194.6	....	....
Average...	'02-'03	842	7672	2840	170	813.8	476.0	435.5	271.6	405.8	....	....	....	....	....
Average...	'02-'04	1032	8155	2279	85	1041.8	301.0	249.7	189.7	202.9	67.8	232.4	97.3	....	....
McGoech	'03-'04	1146	9691	2062	....	123.4	34.6	29.8	62.0	....	47.6	448.0	204.4	....	....
Average...	'01-'03	1288	8282	3493	560	923.3	568.6	641.4	222.7	137.8	....	....	....	63.	1610
Average...	'01-'04	1240	8751	3016	186	1023.	390.6	437.2	169.0	91.8	15.8	149.0	69.8	21.	536
Dorine	'03-'04	1064	7826	1924	....	891.	156.0	28.0	73.5	....	56.0	378.0	115.4	....	....
Average...	'02-'03	857	5716	2613	490	492.2	268.8	187.8	123.4	143.8	....	....	....	56.0	....
Average...	'02-'04	960	6771	2218	245	691.6	162.4	107.9	98.4	71.6	28.0	189.0	57.7	28.	....
Brownie	'02-'03	874	8871	2084	340	838.8	222.0	166.0	135.4	....	128.8	....	....	....	....
Average...	'01-'02	911	10234	3133	490	522.5	407.0	231.0	98.4	41.9	....	....	....	165.3	....
Average...	'01-'03	892	9553	2603	415	680.6	314.5	298.5	116.9	20.9	64.4	....	....	82.6	....
College Rose .	'03-'04	988	7645	1890	....	945.0	11.2	5.6	22.4	11.2	....	519.6	243.6	....	....
Flashlight.....	'03-'04	1027	7870	1621	....	881.2	51.8	25.9	71.9	....	51.8	377.6	121.8	....	....
June..........	'02-'03	867	9159	2031	....	218.0	300.6	170.6	134.0	118.2	39.2	....	....	....	....
Average.	'01-'02	947	9029	2972	210	726.0	664.0	605.0	185.0	118.0	....	....	....	33.0	....
Average...	'01-'03	907	9094	2501	105	472.0	482.0	387.3	158.0	118.1	19.6	....	....	16.5	....
Jennie	'03-'04	1111	6982	1481	....	543.0	100.8	50.4	81.9	....	100.8	285.2	83.1	....	....
Lucy Miller ..	'03-'04	1356	8128	2292	4485	1426.7	136.1	73.7	212.0	....	208.5	935.2	501.2	....	....

Production per cow, '03–'04, and average data, '98–'04.

Cow.	Year.	Live weight.	Days in Milk.		Annual milk.	Fat.	Fat.	Butter.	Value of products.	Cost of feed.	Profit.
			At beginning of year.	During year.							
		Lbs.			Lbs.	Pr ct.	Lbs.	Lbs.	$	$	$
Lady..........	'03–'04	1192	212	322	11632.6	4.22	492.97	575	128.99	51.31	77.68
Average.. .	'01–'03	1176	90	322	10279.7	4.05	416.81	486	109.53	52.83	56.70
Average ...	'01–'04	1181	130	322	10730.7	4.05	435.50	516	116.01	52.32	67.02
Maggie........	'03–'04	1291	45	366	11905.3	3.36	397.92	464	107.12	42.53	64.59
Maud..........	'02–'03	1175	Dry.	291	9694.0	3.80	367.75	429	97.43	33.98	46.45
Average.. .	'98–'02	1148	54	328	8608.8	4.00	345.60	403	90.92	41.79	49.13
Average ...	'98–'04	1161	43	320	8825.8	3.96	350.03	408	92.22	40.23	52.00
Pauline ...	'02–'03	1331	Dry.	324	9682.9	3.80	368.15	429	97.42	35.57	61.85
Average .	'98–'02	1321	162	333	6891.7	4.03	278.54	325	73.25	36.44	36.81
Average ..	'98–'03	1322	129	331	7449.9	3.98	296.46	346	78.08	36.26	41.62
Alma.....	'03–'04	1058	155	310	12242.6	3.05	375.29	438	102.25	41.42	60.83
Average ...	'99–'03	1000	281	320	10930.3	3.20	350.03	408	94.79	50.18	44.61
Average ...	'99–'04	1013	256	316	11216.7	3.16	355.08	414	96.20	48.43	47.85
Donation	'03–'04	1316	141	317	9857.1	3.61	356.26	416	94.96	36.19	58.77
Average ..,	'01–'03	1234	150	333	9792.3	3.60	352.54	412	94.05	40.16	53.89
Average...	'01–'04	1261	147	327	9813.9	3.60	353.77	413	94.35	38.80	55.51
Joe......	'03–'04	1118	189	339	11297.0	3.59	405.95	473	108.28	49.61	58.67
Average ...	'02–'03	850	99	309	9249.9	3.48	322.10	376	86.30	44.08	42.22
Average . .	'02–'04	984	144	324	10273.5	3.54	364.0	425	97.29	46.84	45.44
Campbell......	'02–'03	1186	272	283	7946.3	3.67	291.64	340	77.58	30.81	56.77
Average ...	'99–'02	1110	115	321	7706.3	3.78	291.58	340	77.30	35.09	42.21
Average ...	'99–'03	1128	154	311	7766.3	3.75	291.59	340	77.37	34.02	43.32
Double Time..	'03–'04	915	58	366	7779.0	4.78	371.83	434	96.07	42.64	53.43
Bessie.........	'02–'03	922	25	371	7333.0	4.28	314.31	366	85.55	34.04	51.51
Average ...	'98–'02	899	50	314	7053.8	4.66	328.88	383	85.11	38.88	46.23
Average . -	'98–'03	903	45	325	7109.6	4.58	325.96	379	65.19	37.90	47.29
Muriel	'03–'04	878	42	337	5593.5	5.82	327.08	382	83.19	31.69	51.50
Average ...	'02–'03	800	57	334	5174.2	5.88	304.10	355	77.19	29.26	47.93
Average...	'02–'04	839	49	335	5383.8	5.86	315.59	368	80.15	30.47	49.21
Reba	'03–'04	915	85	325	5730.9	5.29	303.26	353	77.61	33.07	44.54
Average...	'99–'03	813	97	293	5097.3	5.23	266.94	312	68.84	31.60	37.24
Average...	'99–'04	833	94	299	5224.0	5.24	274.21	319	70.59	31.89	38.69
Laura.........	'03–'04	920	280	356	6381.8	5.08	324.65	379	83.41	40.32	43.09
Average...	'02–'03	891	112	334	6439.7	5.19	334.27	390	85.72	38.80	46.92
Average...	'02–'04	905	196	245	6410.8	5.13	329.46	384	84.57	39.56	45.00
McGeoch......	'03–'04	1280	95	371	8465.0	3.63	307.64	359	81.96	39.32	42.64
Average...	'01–'03	1176	116	329	10295.0	3.66	377.47	441	100.44	44.33	56.11
Average...	'01–'04	1210	105	342	9685.	3.65	354.19	413	94.28	42.65	51.62
Dorine	'03–'04	961	62	335	5400.6	5.48	296.23	345	75.60	32.96	42.64
Average...	'02–'03	850	121	319	5522.3	5.38	297.22	347	76.01	27.54	48.47
Average...	'02–'04	906	91	327	5461.4	5.44	296.72	341	75.80	30.25	45.55
Brownie	'02–'03	1035	439	338	5251.0	5.37	282.14	329	72.14	34.87	37.27
Average...	'01–'02	1064	61	364	5356.0	5.54	296.94	346	75.62	34.95	40.67
Average...	'01–'03	1049	250	351	5303.5	5.46	289.54	338	73.88	34.91	38.97
College Rose..	'03–'04	1016	180	317	6334.0	4.14	262.70	306	68.35	34.53	33.82
Flashlight	'03–'04	912	7	325	5275.8	4.86	256.33	299	66.13	32.64	33.49
June	'02–'03	1097	Dry.	322	6937.6	3.75	261.20	304	69.27	37.67	31.60
Average...	'01–'02	1018	81	320	6649.2	3.78	251.26	293	66.56	39.83	26.73
Average...	'01–'03	1057	40	321	6793.4	3.76	256.23	299	67.91	39.85	29.17
Jennie	'03–'04	897	75	332	4471.0	5.70	255.13	278	60.89	29.31	31.58
Lucy Miller...	'03–'04	1113	......	255	6968.0	5.17	360.60	421	91.30	59.94	31.36

DISCUSSION OF HERD RECORDS.

The cow Lady, a grade Red Poll, yielded the largest production of butter fat of any cow in the herd, during the last year, viz., 492.97 pounds, equivalent to 575 pounds of butter. The value of the butter and skim milk that would be obtained from her was $128.99 and the net profit $77.68. This latter figure exceeds that of any other of our cows for last year by $13.00. Lady produced during the year ending Oct. 14, 1903, 13403.7 pounds of milk and 549.10 pounds of butter fat, equivalent to 640.6 pounds of butter, and the net profit returned by her for this period, was $88.49. She was placed on an official test, under the direction of Illinois Experiment Station, on January 9, 1904, thirteen days after calving, and produced during the following seven days, 406.1 pounds of milk and 17.566 pounds of fat, the production of fat per day ranging from 2.25 to 2.69 pounds. For the nine months ending Sept. 27, 1904, she produced 11,723.4 pounds of milk and 484.09 pounds of butter fat; this is a larger production than for the same length of time during any previous year that she has been in our herd, and shows the wonderful dairy capacity of this cow.*

Lady is classified as a dual-purpose cow, from the fact that she has a smooth, even form with even lines, and takes on flesh rapidly when not giving milk. According to her production she is, however, an excellent dairy cow and shows the characteristics of such cows in the manner in which her food is utilized. She has a remarkable constitution and capacity for converting large quantities of food into milk and has improved in this respect with every year that she has been in our herd.

The second place in the herd, during the past year is occupied by the Holstein cow Maggie, which produced 397.92 pounds of butter fat, equivalent to 464 pounds of butter, and yielded a net profit of $64.59. The Shorthorn cow, Maud, comes third in rank, with a production of 30 pounds less of butter fat than Maggie, but yielding nearly the same net

*See Bulletin 102, pages 27-38; Bulletin 107, pages 39-40.

Lady, a grade Red Polled cow, the largest and most economical producer in the University dairy herd, 1903–4. Since she was placed in the herd her annual production of butter fat has been: 1st year, 384 lbs; 2nd year, 449 lbs.; 3rd year, 493 lbs.; 4th year (10 months only), 514 lbs. Maximum production during twelve consecutive months, 549 lbs. of butter fat.

profit. The cows ranking next in order belong to breeds as given: Pauline, Shorthorn; Alma, Donation and Joe, Holsteins; Double Time, Jersey; Bessie and Muriel, Guernseys; etc.

A word of explanation is due to the last two cows in the tables, Jennie and Lucy Miller. The former Guernsey has the lowest cost of feed for the year of any cow in the herd, owing to her poor feeding qualities and delicate health (see page 81). The Jersey cow Lucy Miller, which ranks last in profit returned, made the very creditable production of nearly 7,000 pounds of milk and 360 pounds of fat, equivalent to 420 pounds of butter; owing to the expensive system of feeding, however, which was in part necessary on account of her old age, and partly adopted from a desire to ascertain her maximum capacity as a dairy cow, her feed account ran up very high, viz., nearly $60.00, or 50 per cent higher than the average for the herd, and $8.00 higher than that of Lady, the largest consumer and the best cow in the herd. Lucy is past her best period of usefulness, but must still be considered a very good dairy cow. She ranked No. 8 in the production of butter fat last year, although she gave milk only 255 days during the year. Her short milking period is explained by the fact that she was giving very little milk when placed in the herd, March last year, and was dry from June 1st to Sept. 25th.

The twenty-one cows whose records are given in the preceding tables, gave milk 329 days during the year, on the average, and produced 7,913 pounds of milk and 332.33 pounds of fat, equivalent to 387 pounds of butter; average fat content of the milk, 4.20 per cent. The average value of butter and skim milk from the cows was $86.90, the cost of the feed eaten, $38.24, and the net profit from the cows, $48.66. By reference to bulletin 102, it will be seen that the average production of the herd for the period covered by that bulletin was 7,340 pounds of milk and 307 pounds of butter fat, showing an improvement of about 8 per cent in the average production of milk and butter fat from the herd last year, over that of the directly preceding years.

These figures are not strictly comparable, because the same cows were not kept in the herd for both periods, but they suggest, at any rate, that under the system of feeding adopted last year, the standard of production of previous years has been at least maintained. Of the cows whose records for the year 1903–04 are given in the preceding tables, nine have previously published records. If we summarize the data for these cows for the past years and for last year, the figures shown in the following table are obtained. The data for the single year 1902–1903 are also given in the table for the sake of comparison.

Average production of cows during different periods.

Average for Nine Cows.	Av. 1898–1903	1902–03.	1903–04.
Live weight of cows, lbs	1,005	1,001	1,072
Average age, years	7	6	7
Days in milk	321	313	335
Yield of milk, lbs	8,090.1	8,090.0	8,511.2
Yield of butter fat, lbs	335.72	334.59	354.37
Average per cent. of fat in milk	4.14	4.13	4.17
Estimated butter, lbs	392	389	414
Value of products, $	88.09	87.71	92.92
Cost of feed eaten, $	39.86	37.04	39.40
Average net profit, $	48.23	50.67	53.52

These nine cows produced, on the average, 421 pounds more milk and 18.7 pounds more butter fat during last year, than for the period 1898–1903, an increase of about 5 per cent in either case. The feed cost was decreased with 46 cents per cow, on the average, and the net returns increased with $5.29, an improvement of over 10 per cent. At the same time, the average weight of the cows was increased from 1,005 to 1,072 pounds. Five cows out of the nine produced more milk and gave a large net profit, and six produced more butter during 1903–04 than in the preceding period. The standard of economic production set by our herd during the period 1898–03 has been generally commented on as excellent, and it is, therefore, a source of considerable satisfaction to us that this standard has been still further improved upon during the past year. It is not claimed that the improvement is due wholly to the change in the system of feeding, since as has already been stated, the more nitrogenous feeding did not commence

until half the year had passed, viz., at the beginning of the winter period. The improvement is doubtless due, in part, to the fact that the cows were one year older than last period considered, which brought them, on the average, nearer to their period of maximum production; in part also, perhaps, to the cumulative effect of the good system of feeding and management to which they have subjected since they were placed in our University herd.

BREEDS OF COWS.

In the same way as in previous years, the data relating to the production and feed consumption of the cows belonging to the different breeds have been summarized as a further contribution to the question of the relative merits of dairy breeds. The average figures obtained in this compilation are published below; it is only fair to call attention to the small number of cows included under each breed, which renders pertinent the question whether our selection of cows within the different breeds here represented has been equally successful and equally just to the respective breeds. The difference in the average age of the cows of the different breeds is also a point of importance which should be considered in drawing conclusions as to the merits of the breeds on basis of the data here published. The Red Polled breed is not included in this summary for the reason that it was represented by only one cow in our herd; which, however, as has been shown, stands highest among all the cows in the herd, both as regards her production of milk and butter fat for the year, and the net profit which she returned.

Comparison of breeds represented.

	Jersey.	Guernsey.	Holstein.	Shorthorn.
No. of cows included	5	5	5	5
Average weight of cows, lbs.	980	914	1,214	1,161
Average age of cows, years	8.0	5.2	5.8	6.6
Days in milk	328	340	341	307
Yield of milk, lbs.	6,422.1	5,614.7	10,753.2	8,119.0
Yield of fat, lbs.	328.50	289.82	368.61	310.29
Average per cent. of fat in milk	5.12	5.17	3.42	3.82
Cost of feed, $	42.17	32.13	41.81	35.11
Net profit, $	41.94	42.14	57.10	49.50

TYPES OF COWS.

A discussion is published in bulletin 102 of our Station of the different types of cows, and general definitions are there given of the various types and their characteristics. Without again considering the subject in any detail in this case, we may say that we have representatives of three different types of cows in our dairy herd, viz., *A*, dairy cows of a small size showing much refinement, the so-called *extreme dairy type; B,* dairy cows of a large, strong build, the so-called *large dairy type;* and C, *dual-purpose* or farmers' cows, which combine dairy characteristics with marked beefing qualities when not in milk.

In the bulletin referred to, the production of the cows of these three different types in our herd during the years 1898–1903 has been summarized, with other data bearing upon the value of the cows as dairy animals, and the average results thus obtained showed that the large dairy breeds, represented by twelve cows in the herd during this period, led in the average annual production of butter fat with 325.23 pounds; the extreme dairy cows (14 head) being next with 310.21 pounds; and the dual-purpose cows last, with 292.99 pounds. The rank of the cows according to net profit returned ranged in the same order from $45.31 for the large dairy cows, to $37.82 for the cows of the dual-purpose type.

Similar compilations of last year's records have been made with cows of the different types, and the average results are shown below. The cows whose records for last year have been published on pages 94–95 of this report, have been classified under the three types as follows:

A. *Extreme dairy type*: Alma, Double Time, Bessie, Muriel, Dorine, Flashlight, and Jennie.

B. *Large dairy type*: Maggie, Donation, Joe, Reba, Laura, McGeoch, Brownie and Lucy Miller.

C. *Dual-purpose type*: Lady, Maud, Pauline, Campbell, College Rose and June.

The following table shows the average results of the compilations made for cows of the different types.

Comparison of types of cows.

	Group A. Extreme dairy.	Group B. Large dairy.	Group C. Dual-purpose.
Number of cows included	7	8	6
Average live weight of cows, lbs	936	1123	1166
Average age of cows, years	5.6	8.3	6.7
Average days in milk	339	333	310
Yield of milk, lbs	6870.8	8230.8	8871.2
Yield of fat, lbs	313.60	342.30	340.74
Average per cent of fat in milk	4.57	4.16	3.84
Cost of feed	$33.40	$41.98	$37.31
Net profit	$46.43	$45.11	$54.19

The remarks given in the foregoing pages under Breeds of Cows apply to some extent to these results as well, since only seven, eight and six cows are included under groups A, B, and C, respectively. In Group A, we have two three-year olds and two four-year olds, while under Group B, all the cows but one (a four-year old) are of mature age, and all but one three-year old and one four-year old are mature cows in Group C. It will be noticed from the preceding table that the large dairy cows again lead in the production of butter fat, while the dual-purpose cows come next, and the extreme dairy cows come last, partly on account of the presence of four young cows in this group. In net profit, Group C leads, largely from the fact that the Red Polled cow Lady is included in this group, and Group B comes last, mainly because of the low net profit returned by the Jersey cow Lucy. Here again the withdrawal of one individual will affect in a marked manner the relative position of the three groups. Under these conditions, care should be taken in drawing general conclusions from the average results obtained.

A study of the data on this point will, however, disclose the fact that excellent cows, both as regards productive capacity and economy of production, are found within each group, and also that each group contains cows that must be considered of only average value as dairy animals. The evidence furnished by last year's records gives additional testimony as to the dairy capacity of good dual-purpose cows and suggests that such cows have a proper place to fill with farmers who are so

situated that they cannot or do not wish to make dairying their special vocation, just as much as cows of the dairy type have their proper place among specialized dairy farmers.

RELATION BETWEEN AGE AND LIVE WEIGHT OF COWS AND THE PER CENT OF FAT IN THEIR MILK.

The results of an investigation of the changes in the average quality of the milk produced by cows with advancing age are published in our bulletin 102 (pages 55–56), and it is shown there that, as a general rule, there is a decrease in the average fat content of the milk as the cows grow older, amounting to a couple of tenths of one per cent or more in extreme cases. This fact is brought out in the evidence furnished by compilations of other investigators of dairy problems.*

Last year's records furnish renewed evidence of the relation existing between the age of cows, and the quality of their milk secretion. In the study of last year's results, it was considered of interest to examine into the relation between the body weights of cows and the quality of their milk, and a similar table as that published in our bulletin 102 was, therefore, constructed, which gives information on this point. This table is given below and is largely self-explanatory. Only cows four years old or over are included in this compilation.

*See, e. g., Speir, Milk Records, Transactions Highland and Agr. Society of Scotland, 1904, page 17.

Comparison of weight of cows and per cent. fat in milk for consecutive years.

Cows.	Age at beginning of record	Live Weight.					Per Cent. Fat in Milk.				
		1st year.	2d year.	3rd year.	4th year.	5th year.	1st year.	2d year.	3rd year.	4th year.	5th year.
Ella	6	934	1028	1009	1037	....	5.00	5.10	4.94	4.92	......
Brownie	5	1064	1035	....	....	....	5.54	5.37	......	......	......
Laura	7	891	920	....	....	....	5.19	5.08	......	......	......
Murphy	8	894	927	....	....	....	5.85	5.46	......	......	......
Hoard	4	778	787	826	....	....	5.40	5.16	5.63	......	......
Nan	5	780	760	814	....	....	5.15	4.98	4.62	......	......
Reba	6	682	800	892	878	915	5.62	5.04	5.20	5.14	5.29
Dora	4	995	1091	....	....	....	4.60	4.40	......	......	......
Bessie	7	868	847	894	987	922	4.82	4.74	4.44	4.68	4.28
Chloe	4	1155	1227	1346	....	....	3.88	3.78	3.50	......	......
Alma	4	995	1068	1068	1068	....	3.34	3.15	3.08	3.05	......
Donation	6	1186	1281	1316	....	....	3.69	3.50	3.61	......	......
McGeoch	4	1201	1280	....	....	....	3.54	3.63	......	......	......
Duchess	9	1361	1332	1364	....	....	4.06	4.47	4.04	......	......
Maud	5	1176	1118	1132	1164	1175	4.29	4.18	3.98	3.75	3.80
Belle	5	1210	1306	1298	1395	....	4.14	4.22	3.77	3.71	......
Campbell	6	1097	1058	1174	1186	....	4.03	3.69	3.69	3.69	......
Pauline	5	1370	1301	1247	1364	1331	4.18	4.16	3.99	3.91	3.80
Lady	5	1158	1193	1192	....	....	4.03	4.08	4.23	......	......
Av. (19 cows)	**5.5**	**1042**	**1072**	**1112**	**1135**	**1086**	**4.54**	**4.43**	**4.34**	**4.11**	**4.29**
Av. 5 yr. series (4 cows)	......	**1024**	**1017**	**1041**	**1098**	**1086**	**4.73**	**4.53**	**4.40**	**4.37**	**4.29**
Av. 4 yr. series (8 cows)	.....	**1041**	**1066**	**1089**	**1135**	....	**4.43**	**4.29**	**4.14**	**4.11**	......
Av. 3 yr. series (14 cows)	.....	**1034**	**1079**	**1112**	....	....	**4.40**	**4.30**	**4.18**	......	......

The averages for all nineteen cows for which the body weights and percents of fat are given during consecutive years, show an increase in the live weight and a decrease in the per

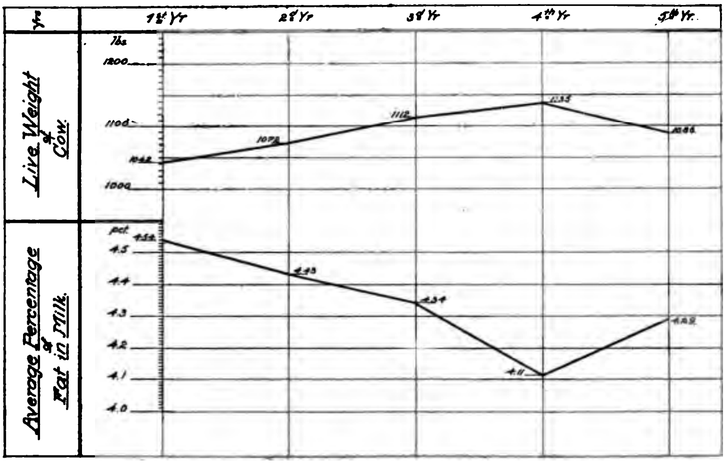


FIG. 22.—Diagram showing relation of live weight of cows and quality of milk produced during consecutive years.

cent of fat for every year up to the fifth one, of their life in our herd; in the fifth year, there is a decrease in live weight and a coincident increase in the per cent of fat. While perfectly regular and concordant in their relation, these average figures are subject to criticism from the fact that the number of cows included in the various years is not the same. This objection is overcome in the data presented in the last three lines of the table showing averages for all cows that have been in our herd for five, four, and three consecutive years, respectively. The first series do not show concordant results with those of the general averages, as it would appear, on account of the small number of cows furnishing data for the series, but in the case of the last two series, the evidence is conclusive that cows above five years of age up to their ninth or tenth year under normal conditions increase in weight from year to year, and at the same time the average quality of their milk secretion is lowered for every year by about .1 of one per cent.

COMPOSITION OF FEEDING STUFFS FED TO THE HERD, 1903–04.

The following table gives the results of the chemical analyses of the various feeding stuffs which were fed to the herd during the past year. Samples of silage were taken once a week during the winter for determinations of dry matter, and the dry samples were kept until the end of the period, when a composite sample was taken of them for complete chemical analysis. The other feeds were sampled every time a new sup-

Composition of feeding stuffs, 1903–04, in per cent.

	Hay.	Corn silage.	Corn and soy bean silage.	Soy bean silage.	Wheat bran.	Oats.	Corn.	Oil meal.	Gluten feed.	Distiller's grains.	Cotton seed meal.
Moisture	8.00	72.03	73.20	73.92	10.95	6.08	11.50	8.45	7.55	5.26	7.03
Ether extract	2.45	1.01	1.06	2.10	3.50	3.95	4.20	9.23	3.13	9.37	9.70
Crude protein	6.68	2.21	2.40	4.09	15.00	10.13	9.38	32.50	24.38	29.94	41.56
Crude fiber	33.16	5.88	5.89	7.94	13.95	13.25	2.38	8.03	7.28	11.91	7.68
N. free extract	44.79	17.19	15.52	8.79	49.67	62.19	72.04	36.31	55.33	41.77	27.09
Ash	4.92	1.68	1.93	3.16	6.93	4.40	1.50	8.03	2.33	1.75	6.94
Dry matter	92.0	28.01	26.8	26.1	89.1	93.9	88.5	91.6	92.5	94.7	93.01
Dig. protein	3.8	1.1	1.3	2.7	11.9	7.9	7.1	28.9	20.5	22.2	36.6
Dig. carb. and fat	51.5	17.3	15.0	11.8	42.8	57.4	76.5	51.4	59.4	60.5	40.1
Nutr. Ratio, 1:	13.6	15.7	11.5	4.4	3.6	7.3	10.8	1.8	2.9	2.7	1.1

ply was received at the barns. The digestion coefficients of the various feeding stuffs given by Jordan have been used for the calculation of the digestible components of the rations.

WINTER RATIONS FED TO THE HERD.

The period here considered began November 18, 1903, and continued for six months. During this time the composition of the feeds eaten by the cows could be accurately determined, from the fact that the cows were not then given any feed except what was weighed out to them in the barn. The data for feed consumption and production of milk and butter fat during this period, therefore, furnish valuable material for a study of the interrelation of these factors.

Twenty-eight cows completed records for the last winter period. The data for these cows are given in the following table, which supplies information as to length of the milking period, live weights of the cows, composition of rations fed, average amount of grain fed daily, and production of milk and butter fat. It may be in order to state that the large amount of grain fed to the cows Joe, Lucy, Josephine, and Artis, were given with the expectation of obtaining a maximum flow of milk from these cows, and with a view of increasing their future usefulness in the herd, and not because their actual production was considered sufficiently large to warrant feeding such amounts.

It will be noted that the average amounts of grain fed per day for the winter period ranged between 13.2 pounds for Lucy to 4.5 pounds for Bessie; the small amount of grain given the latter cow is explained by the large portion of the period considered in which she was not giving milk. The figures for the average production of milk and butter fat given in the table have been obtained by dividing the total yields of milk and butter fat produced by the cows, by the total number of days in the winter period; since our main object in obtaining these figures was to study the relation between the feed consumption and the production of the cows during the winter period, it is believed that the data thus arrived at are of more

value than would be the case if the calculation had been based on the actual number of days during which the cows were giving milk.

Average winter rations fed to cows in University herd, 1903–04.

NAME OF COW.	Days from calving, Nov. 18.	Days in milk, Nov. 18–May 18	Period dry.	Live weight.	RATIONS FED.			Nutritive ratio.	Average grain per day.	Milk in lbs.	Fat, lbs.	Fat, per cent.
					Dry matter.	Dig. prot.	Dig. carbo-hydrates.					
Lady	Dry	142	Nov. 18—Dec. 27	1,169	26.95	2.68	15.40	1:5.7	10.3	36.7	1.56	4.25
Maggie	244	181	....	1,334	26.50	2.47	15.33	6.2	7.7	26.2	.89	3.40
Maud	290	181	....	1,188	25.49	2.22	14.75	6.6	7.9	21.9	.95	4.34
Alma	Dry	118	Nov. 18—Jan. 20	1,083	21.96	2.23	12.93	5.8	10.4	34.7	1.07	3.09
Donation	Dry	140	Nov. 5—Dec. 29	1,301	23.10	2.36	13.51	5.7	8.8	28.0	1.04	3.71
Campbell	197	181	....	1,211	20.77	1.65	12.23	7.4	5.6	14.5	.61	4.21
Double Time	248	181	....	970	23.63	2.28	13.76	6.0	7.8	16.4	.85	5.18
Bessie	376	79	Nov. 22—Mch 4	1,032	18.02	1.33	10.01	7.5	4.5	10.7	.57	5.32
Muriel	231	138	Feb. 19—Apr. 3	936	18.87	1.31	11.03	8.4	5.1	12.4	.77	6.21
Joe	Dry	168	Oct. 30—Dec 1	1,107	26.05	2.94	15.54	5.3	12.9	41.3	1.47	3.56
Reba	264	136	Feb. 25—Apr. 11	969	19.18	1.60	11.25	7.0	5.5	11.2	.65	5.86
Laura	115	181	....	955	22.98	2.16	12.96	6.0	8.3	16.1	.83	5.16
McGeoch	284	181	....	1,355	23.93	2.19	13.79	6.3	8.2	13.7	.54	3.94
Dorine	251	145	Feb. 23—Mch. 31	1,022	19.02	1.61	11.07	6.9	5.4	11.7	.70	5.98
Brownie	Dry	155	Oct. 25—Dec. 14	1,035	21.63	2.24	12.71	5.7	8.1	21.9	1.28	5.84
College Rose	Dry	165	Oct. 11—Dec. 4	1,029	20.57	2.04	11.91	5.8	7.2	24.2	1.00	4.12
Flashlight	226	140	Mch. 21—May 11	975	18.89	1.64	11.00	6.7	5.5	10.9	.56	5.14
June	326	147	Dec. 4—Dec 23	1,259	24.39	2.23	14.20	6.4	7.4	17.6	.67	3.81
Jennie	266	143	Feb. 23—Apr. 2	954	17.03	1.34	9.92	7.4	5.2	9.7	.59	6.09
Lucy Miller	54	181	....	1,089	28.68	3.55	16.99	4.8	13.2	26.7	1.43	5.36
Josephine	61	181	....	1,044	27.34	3.05	16.33	5.4	11.2	32.3	1.15	3.56
Julia	60*	181	....	1,272	27.55	2.61	15.16	5.8	8.8	30.5	1.20	3.93
Topsy	200*	181	....	1,096	25.29	2.34	14.81	6.3	7.9	24.2	1.03	4.26
Artis	Dry	164	Nov. 18—Dec 5	966	24.22	2.80	14.21	5.1	10.6	25.3	1.01	3.99
Marcella	90*	181	....	803	19.14	1.94	11.63	6.0	7.1	14.6	.92	6.30
Floradora	225*	181	....	889	19.86	1.96	11.52	5.9	6.7	14.1	.76	5.39
Celia	Dry	175	Nov. 18—Nov. 24	1,077	22.98	2.39	13.55	5.7	8.7	14.6	.68	4.66
Lina	200*	166	Apr. 8—Apr. 26	1,008	20.68	2.04	12.05	5.9	7.2	14.2	.64	4.51
Average	......	160		1,076	22.65	2.19	13.20	6.0	8.0	20.58	.908	4.41

*Approximately.

The cows are arranged in this table in the same order as in the table on pp. 94–95, viz., according to decreasing net profits for the year 1903–04, with the exception of the last eight cows in the table, for which records for the winter period only were obtained. The last line of the table shows the average data for the twenty-eight cows that were in the herd during the whole winter period; we notice that the average body weight of the cows was 1,076 pounds, the average daily ration fed contained 22.65 pounds dry matter, 2.19 pounds digestible protein, 13.20 pounds digestible carbo-hydrates and fat; the nutritive ratio of this ration is 1:6.0; the average production

of the cows per day during the entire period was 20.58 pounds milk and .908 pounds fat.

The amount of dry matter in the rations fed to the different cows ranged from 18.02 pounds (Bessie) to 28.68 pounds (Lucy Miller); the digestible protein ranged from 1.31 pounds (Muriel) to 3.55 pounds (Lucy Miller); the digestible carbohydrates and fat from 9.92 pounds (Jennie) to 16.99 pounds (Lucy Miller), and the nutritive ratio from 1:4.8 (Lucy Miller) to 1:8.4 (Muriel). It is worthy of note that even with the rations fed last winter, which were relatively high in protein, nine out of the twenty-eight cows received less than two pounds of digestible protein, on the average. These nine cows were, however, all well advanced in their lactation at the beginning of the winter period and their production during the winter period was rather low, which accounts for the light rations fed and the relatively small amounts of protein which they received. No cow producing more than one pound of butter fat per day for the whole winter period received less than two pounds of digestible protein in their average daily rations, and all cows receiving more than 2.5 pounds of digestible protein, with but few exceptions, produced considerable over one pound of butter fat per day. It may be said, in general, that a high protein feeding resulted in, or was associated with, a high daily average production of milk and butter fat.

The changes in the body weights of the cows during the winter period do not appear from the average figures given in the table, but on comparing the weights at the beginning and the end of the winter period, on our records for all cows whose body weights were not increased through the growth of a foetus, we notice that sixteen cows considered in this compilation increased during this time, on the average, 47 pounds per head, the largest increase occurring in the case of Maud (110 lbs.), Marcella and Floradora (95 lbs.) and Celia (90 lbs.), and that only four cows out of this number went down in weight during the period, viz., Lady (50 lbs.), Brownie (30 lbs.), Lucy Miller (20 lbs.), and College Rose (10 lbs.). If we are justified in assuming that the rest of the cows responded to their feed in a similar manner as these sixteen

cows, we should, therefore, credit the rations fed with producing an average increase of about fifty pounds per head during the winter period. This increase in the young cows in the herd came, perhaps, largely through the natural growth in size, while with the other cows, a deposition of fatty tissue must have taken place, since succulent feeds were fed both at the beginning and the end of the period.

For the sake of comparison, a similar compilation has been made of the weighings of the cows in our herd at the beginning and the end of the winter period, 1902–1903, and the following data were obtained for eleven cows: Average weight at beginning of period, 1,038 lbs., at the end, 1,052 lbs., an average increase per head of fourteen pounds. Five cows went down in weight during this period and six went up, showing that there was a greater tendency toward production of flesh in the case of the rations fed last winter than with those fed during the preceding winter period.

The specific influence of the more nitrogenous ration fed last winter, as regards the production of the cows, can not be determined by a comparison of the average rations fed and the production of the herd during the two winters, for the reason that new cows were added, and old cows disposed of in the mean time. It is necessary in order to obtain data for such a comparison, to consider only the cows that were in the herd both seasons. Such data are at hand for fourteen cows in all. Wider nutritive ratios were, however, fed last year than in 1902 to the two cows Bessie and Muriel, and the data for these cows cannot, therefore, be considered in making this compilation, leaving twelve cows that furnish evidence for a direct comparison of the effect of last winter's more nitrogenous system of feeding than that of the preceding winter. The average data for these cows are given in the following table.

Comparison of winter rations (average for 12 cows).

	1902-03.	1903-04.	Difference.
Rations fed.			
Dry matter, lbs	22.89	22.95	+.06
Digestible matter, lbs	15.44	15.54	+.10
Digestible protein, lbs	1.89	2.18	+.29
Average nutritive ratio	1:7.5	1:6.2	—1.3
Production.			
Average daily milk yield, lbs	22.6	22.4	—.2
Butter fat per day, lb	.896	.947	+.051
Average per cent. fat	3.97	4.23	+.26
Arithmetrical mean of per cents of the milk of single cows	4.18	4.47	+.29
Average live weight, lbs	1,070	1,137	+.67
Total grain per day, lbs	7.2	8.2	+1.0
Days in milk during winter	147	156	+9

The rations fed during the two winters were practically the same, so far as both total dry matter and digestible matter are concerned, but .29 pound more digestible protein were fed during 1903–04 than the preceding winter, which caused the narrowing of the nutritive ratio from 1:7.5 to 1:6.2. This result was brought about by feeding grain mixture of a narrower nutritive ratio (see page 76) and by feeding somewhat more grain. The latter change was, in part at least, necessitated by the poor quality of the hay fed last year compared with that fed previous years.

The effect of the change made in the rations is seen in the production and the live weights of the cows. We note that there are but small differences in the average yields of milk and butter fat, but a somewhat marked improvement in the average quality of the milk produced by the cows last year, and a decided gain in their average live weights. Of the twelve cows here considered, every cow except Laura and Alma improved in the average quality of milk produced. The milk of the former cow contained .14 per cent less fat last winter than in 1902–03, and the latter .01 per cent less fat, or practically the same per cent in both years. This, it would seem, is a very striking effect, and one which may prove of great importance to milk producers. A careful study of the data obtained

during the two seasons has failed to disclose any points of difference in the management of the cows or in the rations fed, except the higher protein feeding last year, that could be considered the cause of this improvement in the quality of the milk observed.

The effect of last season's rations in increasing the average weight of the cows was almost as marked as the average increase in the fat content of the milk; all but three cows gaining in weight, viz., from 214 lbs. (June) to 22 lbs. (Lady). The three cows that lost weight were Maud (21 lbs.), Campbell (14 lbs.), and Brownie (1 lb.), making the comparison practically a gain for nine cows and a loss for two cows.

On page 103 of this report, we have called attention to the fact that, as a general rule, a high live weight in dairy cows is associated with a relatively low per cent of butter fat in their milk; the influence of the system of feeding practiced last year on the quality of the milk produced by the cows must, therefore, have been concealed to some extent by the change in the live weights of the cows, and it would seem, for this reason, that the change in the quality of the milk, caused by the more nitrogenous feeding, must be considered lower rather than higher than the data obtained.

The effect of the food on the quality of the milk produced shown by our results is contrary to the views on this subject held by most dairy authorities at the present time. The opinion generally advanced is, that the food does not appreciably change the quality of the milk, provided the rations fed contain at least average amounts of food components. This view has been accepted largely, if not wholly, as the result of numerous feeding trials with cows, which have been of short duration and often including only a few animals, while in our results two periods covering six months each, and the performance of a large number of cows are considered. At the same time, the teachings of our results would lead to such a radical departure from the accepted views, that it is only safe to await at least another season's feeding trial along the same line, before they are considered true expressions of the

influence of food to dairy production. It is our plan, therefore, to continue this study during the coming year, in the hope that further evidence will thus be obtained as to the effect and the desirability of feeding dairy cows more nitrogenous rations than has heretofore been considered advantageous under the conditions prevailing in the central west.

OFFICIAL TESTS OF DAIRY COWS, 1903-04.

F. W. WOLL.

A brief history of the so-called official tests of pure-bred dairy cows conducted by this Station was published in our bulletin No. 107 (December 1903, 43 pages), with an account of the work done in this line during the year 1902–3. This work was first taken up by our Station in 1886, but was not of much importance prior to 1894, when the Holstein–Friesian Association adopted the system of official tests of cows for entry in the Advanced Register of this Association. Since that time the work has grown steadily from year to year, and the past year witnessed a much larger increase in the number of tests which we were called upon to conduct than any previous year.

The tests are conducted for the most part in cooperation with two associations of pure-bred dairy cattle, the Holstein-Friesian Association of America and the American Guernsey Cattle Club. The system of testing adopted by these two associations differs in the length and the frequency of the tests, those of the Holstein cows being, as a rule, conducted for seven or for thirty consecutive days, and those of the Guernsey cows for one day once every month throughout the year. At the last annual meeting of the Holstein–Friesian Association a new series of tests was inaugurated, viz., of cows eight months from the time of calving; these tests are intended to show the persistency of the milk productions of the cows. According to present indications there will be many applications for men to conduct tests of cows at this stage of their lactation period in the future, which will have to be provided for, in addition to a larger number than ever before of cows at the height of their dairy production, shortly after calving.

Up to last year the Station had conducted 950 official tests in all, mostly seven-day tests of Holstein cows, but other breeds of dairy or so-called dual-purpose cattle were also represented in this number, viz., Jersey, Guernsey, Red Polled, Short Horn and Brown Swiss. The number of tests conducted by us during the year ending October 1, 1904 was as follows:

a, *Seven-day tests;* of Holstein cows 234, Guernseys 3; Jerseys 5, other breeds (Red Polled, Shorthorn, Brown Swiss and grade Holsteins) 10; total 252.

b, *Thirty-day tests;* 21, all of Holstein cows.

c, *Thirteeen to sixty-day tests;* 10, likewise all of Holstein cows, making a total of 283 tests conducted for periods of seven to sixty days each, against 171 similar tests during the year 1902–3.

The number of pure-bred cows that were included on these tests aggregated 256. In addition, monthly one-day tests were made of 78 Guernsey cows and 4 Jerseys, the greater number of these tests being continued throughout the year. In 1902–3, thirty–five Guernsey cows and sixteen Jersey cows were tested.

The total number of tests of cows of the various breeds which have been conducted by us up to the present time is as follows:

Of Holstein–Friesian cows	983
Guernsey cows	150
Jersey cows	104
Red Polled cows	34
Shorthorn cows	11
Brown Swiss cows	9
Grade cows	23
Total number of tests	1,314

Of this number all but 104 were conducted since 1894, and 364, or 27.7%, were conducted during the year covered by the present report, ending October 1, 1904.

The number of different breeders whose cows were tested last year were as follows: Holstein breeders 26, Guernsey 10, and Jersey 2, a total of 38 breeders. Five of the Holstein breeders had cows in their herds tested for the first time last year, while six of the Guernsey herds and one of the Jersey herds were tested last year for the first time.

When we consider the rapid growth of these tests during late years and the large number of breeders of pure-bred cattle in this state who have not as yet availed themselves of the opportunity offered by the system of official dairy tests to have the production of their cows accurately determined, it seems next to certain that the future growth of the tests will be still more rapid than it has been in the past. Owing to the heavy tax on the resources of the Station in taking care of the work laid upon us with these tests by the breeders of the state, we have made no effort to push this work, and it has not been possible to assist to any large extent in the further development of this system of testing cows, by contributions to the agricultural press, by lectures before dairy associations, or by visits to the various farms to secure photographs of the best producers among the cows and to study phases of dairy production, for which these cows furnish especially valuable material. If a specialist in dairy husbandry were placed in charge of the tests who could give his entire time to the work, their usefulness to the dairy industry of our state and to our Station, by supplying valuable data for studies in milk production, would be greatly increased; it is not difficult to see that the somewhat heavier expense which such a change would incur would be returned many times to our live stock interests and to the state, and would be a strong aid in spreading the fame of Wisconsin as a prominent dairy state throughout the Union, as well as to foreign countries.

Practically all of the tests conducted up to this time have been with pure-bred cows. A further and most important extension of the work would be to inaugurate a regular system of testing cows found on our ordinary dairy and other farms. These cows furnish nine-tenths or more of the milk produced in the state, and are perhaps capable of still further improvement than the pure-bred cows, which are, generally speaking, kept by business farmers who give their cows the best of care and attention. The educational value and indirect money value of a systematic testing of grade and native cows on Wisconsin farms can hardly be overestimated, and tests of cows of this class may be confidently expected to return manifold interest on the money expended on their conduct. So far it has, how-

ever, been impossible for us to extend the system of testing cows to this class. The work done by us along this line has increased through no efforts on our part, except through the publication of the results of the tests in bulletin form, but has come through the demand of the breeders of the state for assistance in determining the production of their cows by competent disinterested experts, so that the results shall be received by the general public without a question.

TESTS CONDUCTED DURING 1903-4.

The tests which were conducted during the year ending October 1, 1904, are reported in the following. As in previous years the results are given for each breed separately, beginning with cows of the Holstein–Friesian breed, which as usual furnished cows for nearly three-fourths of the number of tests conducted by us last year. The cuts of cows given in the following pages are reproduced from photographs furnished by the various breeders; they are intended to give a somewhat definite idea as to the conformation and appearance of some of the best cows whose records are given in this report. It was found impossible in several cases to secure good photographs of cows that would be entitled to be shown with the others, from the records made by them in official tests during last year.

A. OFFICIAL TESTS OF HOLSTEIN COWS.

It has already been stated that the main work in testing dairy cows done by us during the past year, as heretofore, has been with cows of the Holstein breed. Two hundred and sixty-nine different tests of Holstein cows were conducted during the year, viz., 234 seven-day tests, 21 thirty-day tests and 10 tests ranging in length from thirteen to sixty days. The great majority of the cows whose tests are given in this report came up to the requirements of the Holstein–Friesian Association for admittance to the Advanced Register of this Association; the tables given in the following include all tests conducted by us for a period of seven days or more, whether the cows qualified or not.

Seven-day tests.— Two hundred thirty-four seven-day tests of 219 different Holstein cows were conducted during the year. The names and addresses of the breeders whose cows were tested during the year are given below, the numbers in each case referring to those in the column headed "Cow No.", in the subjoined tables.

OWNERS OF HOLSTEIN COWS TESTED DURING THE YEAR ENDING OCT. 1, 1904.

1. F. W. Allis, Madison, Wis., Nos. 1, 2, 18, 64, 65, 66, 67, 98, 99, 100, 102, 103, 104, 112, 117, 134—16 cows.
2. Frank Brewster, Bowers, Wis., Nos. 43, 57, 90, 116—4 cows.
3. M. S. Campbell, Genoa, Ill., Nos. 41, 87, 147—3 cows.
4. W. S. Carpenter, Menominee, Mich., Nos. 12, 59, 85, 114, 133, 158, 159, 160, 161—9 cows.
5. A. C. Demerit & Son, Lake Mills, Wis., Nos. 23, 62, 115, 191—4 cows.
6. William Everson & Sons, Lake Mills, Wis., Nos. 7, 26, 39, 42, 60, 92, 172, 205, 206—9 cows.
7. E. J. Fargo, Lake Mills, Wis., Nos. 24, 46, 47, 63, 84, 135, 136, 140, 165, 182—10 cows.
8. F. B. Fargo, Lake Mills, Wis., Nos. 13, 20, 56, 113, 144, 166, 173, 173a, 177, 179, 190, 195, 207, 217—14 cows.
9. M. H. Gardner, Darien, Wis., Nos. 78, 93, 94, 95, 105, 106, 121, 122, 146, 178, 208, 209, 210—13 cows.
10. W. R. Gates, Ft. Atkinson, Wis., Nos. 17, 21, 52, 200, 213—5 cows.
11. L. W. Gay, Madison, Wis., Nos. 38, 48, 53, 55, 86, 181—6 cows.
12. Gillett & Son, Rosendale, Wis., Nos. 37, 70, 83, 167, 168, 169, 170, 171, 201, 202—10 cows.
13. S. B. Jones & Son, Watertown, Wis., Nos. 9, 14, 15, 16, 29, 30, 32, 33, 79, 80, 81, 141, 142, 153, 183, 184, 185—17 cows.
14. W. H. Jones, Watertown, Wis., Nos. 3, 28, 31, 45, 51, 73, 77, 119, 126, 143, 152, 174, 175—13 cows.
15. John Legler & Son, Juda, Wis., Nos. 10, 22, 25, 35, 68, 71, 108, 125, 137, 138, 148, 198, 215, 216—14 cows.
16. A. N. McGeoch, Milwaukee, Wis., Nos. 27, 36, 44, 61, 82, 88, 97, 123, 124, 149, 151, 164, 180, 186, 192, 193, 194, 199—18 cows.
17. E. C. Petrie, Elkhorn, Wis., Nos. 58, 211—2 cows.
18. E. E. Randall, Watertown, Wis., Nos. 74, 75, 76, 109, 110, 111, 128, 129, 131, 132, 154, 155, 156, 157, 187, 188, 212—17 cows.
19. Reddelien Bros., North Lake, Wis., Nos. 8, 196—2 cows.
20. J. Rust, West Allis, Wis., Nos. 11, 40, 72, 89, 107, 120, 145, 150, 203, 204—10 cows.
21. C. A. Schroeder, West Bend, Wis., Nos. 4, 6, 96, 172a—4 cows.
22. Aug. Seefeldt, Hochheim, Wis., No. 69—1 cow.
23. Univ. of Wis., Madison, Wis., Nos. 19, 101, 162, 163—4 cows.
24. Henry Walsh, Sheboygan Falls, Wis., Nos. 49, 50, 118, 197, 214—5 cows.
25. A. L. Williams, Fond du Lac, Wis., Nos. 5, 34, 54, 91, 127, 130, 139, 176, 189—9 cows.

The tests of the cows owned by the University of Wisconsin were conducted under my direction, as all other official tests in the state here reported, and composite samples and all records were submitted to Professor W. J. Fraser, in charge of the

dairy husbandry department of the University of Illinois, on completion of the tests for verification. The composite samples of milk received on the various tests during the year were for the most part made by Mr. Geo. A. Olson, assistant chemist, or under his supervision.

In conducting these tests the Station employed eleven young men, nearly all graduates of the Short Course in Agriculture or the Dairy Course in the University of Wisconsin. Two more men assisted in two other tests, viz., Mr. Geo. A. Olson, in conducting Guernsey tests and a retest of the Holstein cow Ava Colanthus Piebe (see p. 132), and Mr. W. B. Richards, assistant in animal husbandry at this Station last year, in conducting Guernsey tests. The names of our supervisors of dairy tests during the past year, with the cows tested by each of them, are given below.

SUPERVISORS OF DAIRY TESTS.

1. **John P. Bonzelet, Eden, Wis., Nos. 10, 22, 49, 50, 137, 197, 198, 214—8 cows.**
2. **John C. Brown, Madison, Wis., Nos. 67, 100, 102—3 cows.**
3. **H. L. Cockerill, Berlin, Wis., Nos. 28, 34, 45, 51, 54, 113, 127, 130, 176, 189—10 cows.**
4. **L. R. Davies, Madison, Wis., Nos. 18, 28, 65, 66, 75, 76, 103, 126, 129, 131, 132, 157—12 cows.**
5. **R. Elliot, Madison, Wis., Nos. 13, 17, 20, 24, 26, 29, 36, 39, 46, 47, 52, 63, 69, 78, 84, 86, 95, 105, 106, 128, 135, 136, 140, 144, 146, 149, 165, 166, 172, 173, 173a, 177, 178, 179, 180, 182, 184, 185, 187, 188, 192, 193, 194, 195, 200, 205, 206, 208, 209, 210, 213—51 cows.**
6. **James A. Ford, Sparta, Wis., Nos. 5, 9, 21, 25, 29, 30, 31, 32, 33, 35, 43, 57, 58, 68, 71, 81, 90, 91, 94, 108, 116, 119, 121, 122, 125, 138, 139, 148, 152, 153, 174, 183, 211, 215, 216—35 cows.**
7. **O. J. Hanzlik, Hillsboro, Wis., Nos. 20, 23, 24, 26, 40, 46, 47, 56, 59, 60, 62, 85, 89, 97, 107, 118, 120, 123, 124, 133, 136, 159, 161, 164, 173a, 186, 195, 203, 205, 206, 207, 217—32 cows.**
8. **Roy T. Harris, Warrens, Wis., Nos. 2, 11, 38, 44, 56, 61, 70, 72, 74, 75, 76, 82, 83, 88, 93, 97, 99, 101, 104, 109, 110, 111, 112, 145, 150, 151, 154, 162, 163, 165, 182, 190, 204, 215, 216—35 cows.**
9. **Bryant R. Ryall, Augusta, Wis., Nos. 1, 4, 6, 7, 8, 12, 14, 15, 16, 19, 27, 42, 64, 73, 77, 79, 80, 92, 96, 98, 104, 112, 114, 115, 117, 134, 141, 142, 143, 155, 156, 158, 160, 172a, 191, 196, 199, 212—38 cows.**
10. **Frank Stark, Randolph, Wis., Nos. 3, 28, 31, 37, 41, 45, 51, 87, 147, 152, 167, 168, 169, 170, 171, 175, 201, 202—18 cows.**
11. **A. Ystgard, Urbana, Ill., Nos. 48, 53, 55, 181—4 cows.**

Official tests of Holstein cows, 1903-1904.

Cow No.	Name of Cow.	Herd book No.	Test began	Age.	Days in milk.	Yield in Seven Days. Milk.	Yield in Seven Days. Fat.	Per Cent Fat. Ave.	Per Cent Fat. Range.	Fat Per Day. Range.	Temperature of Cows. Ave.	Temperature of Cows. Range.
	Class I—Cows five years old or over.			Y. M. D.		Lbs.	Lbs.	Pr ct.	Pr ct.	Lbs.	°F.	°F.
1	Aagge Lotta 3d	11796	Feb. 29	15— 9— 9	8	307.9	10.600	3.27	3.2 - 4.25	1.375-1.599	....	....
2	Anna Clothilde	25384	Jan. 26	13— 0— 4	68	382.3	11.706	3.06	2.35- 3.45	1.550-1.760	....	....
3	Piebe Laura	27248	Mar. 9	12— 9— 7	12	419.2	16.190	3.86	3.1 - 4.8	2.169-2.534	....	....
4	Netta Netherland Van Beers	31401	Apr. 19	12— 4—22	11	437.5	14.928	3.41	2.65- 4.2	2.038-2.252	....	....
5	Madam Wickfield	32652	Dec. 15	11— 6—26	39	411.6	14.582	3.54	3.2 - 4.4	1.860-2.247	101.2	101.0-2.0
6	Netherland Bessie[1]	35997	Apr. 20	10— 9—15	38	528.3	19.974	3.78	3.4 - 4.2	2.791-2.938	....	....
7	Rebecca Babins	37099	Dec. 9	9—11— 6	7	342.1	14.523	4.25	3.65- 5.4	1.869-2.174	101.9	101.0-2.4
8	Winnie Wartena Netherland[2]	37630	May 3	10— 7— 7	11	535.7	21.419	4.00	3.35- 4.75	2.789-3.158	102.7	102.0-3.4
9	Wild Rose Jones 2d	37839	Mar. 30	9— 9—11	33	434.9	15.426	3.54	3.1 - 3.9	2.094-2.331	102.1	102.0-2.3
10	Lady Tietje Mercedes	38791	Apr. 6	8—11—23	33	342.0	10.153	2.96	2.1 - 4.8	1.297-1.688	100.7	100.0-1.3
11	Aaltje Salo 5th Netherland	38798	Nov. 7	9— 0—22	24	329.7	12.119	3.68	2.7 - 4.65	1.312-1.951	....	....
12	Vevie Night 2d Dorinda	39388	Jan. 11	8— 9— 3	11	386.7	12.959	3.35	2.8 - 4.0	1.787-1.896	....	....
13	Aaggie Colantha	39503	Oct. 7	8— 8—	—	327.0	10.758	3.29	2.5 - 5.0	1.388-1.631	103.7	102.5-4.8
14	Pauline Whitney	39946	Oct. 31	8— 7— 1	25	404.9	14.997	3.70	3.0 - 4.45	1.896-2.402	103.2	102.8-3.6
15	Lady Oak 2d	39947	Oct. 31	8— 6—16	26	429.3	16.250	3.79	3.18- 4.18	2.193-2.382	102.0	101.6-2.5
16	Jessie Fobes 5th	39948	Oct. 31	8— 6—17	31	479.6	15.201	3.17	2.25- 4.28	1.906-2.324	103.0	102.8-3.2
17	Ethel H	40467	Dec. 27	8— 2—11	15	411.8	13.282	3.23	2.2 - 4.0	1.698-2.132	101.8	101.6-2.0
18	Waverly 2d's Netherland	40950	Apr. 23	8— 3— 7	11	325.6	12.507	3.84	2.85- 4.65	1.711-1.890	....	....
19	Alma Marie 3rd	41417	Feb. 3	7— 9—26	15	463.2	15.209	3.28	2.6 - 5.5	2.092-2.265	....	....
20	Netherland Ida	41501	Apr. 1	8— 1—23	7	335.7	16.299	4.85	3.3 - 7.5	1.616-2.583	102.9	102.1-3.7
21	August Wit	41515	Jan. 15	7— 5— 3	11	393.5	14.069	3.59	2.9 - 5.0	1.470-2.254	102.2	101.8-3.0
22	Julian Anne Netherland	42127	Apr. 8	7—10— 6	37	434.9	12.655	2.90	2.2 - 3.95	1.738-1.861	101.6	101.0-2.3
23	Aaggie Barbetta	42145	Dec. 17	7— 7— 1	26	364.8	14.712	4.03	3.3 - 5.15	2.036-2.182	102.8	102.5-3.0
24	Lady Neltje Maid	42517	Apr. 7	7— 0—20	21	333.0	13.302	3.99	3.3 - 4.85	1.829-2.107	102.4	102.0-2.8
25	Lady America Wayne Paul De Kol	43738	May 18	6— 2—25	34	485.6	14.161	2.91	2.0 - 5.4	1.753-2.461	102.2	102.0-2.5
26	Canary's Mercedes Victoria	43780	Mar. 3	6— 2—22	22	482.2	16.586	3.44	2.45- 5.05	2.200-2.579	102.2	101.7-2.6
27	Aaltje Salo Princess May	43961	Apr. 12	6— 2— 8	5	354.5	15.456	4.36	2.65- 7.75	1.916-2.757	100.7	100.4-1.0
28	Jessie Fobes 2d Maud 2d[3]	44123	Apr. 12	6—11—13	11	490.0	19.479	3.97	3.6 - 4.4	2.761-2.830	...	....
28	Jessie Fobes 2d Maud 2d	44123	June 11	6—11—13	71	514.6	16.163	3.12	2.2 - 4.1	2.049-2.535	101.2	100.6-2.0
29	Grace Fayne 2d[4]	44124	Apr. 16	7— 2—25	21	577.4	20.521	3.55	3.2 - 4.2	2.724-3.107	102.7	102.5-3.2

[1] Awarded ninth prize. [2] Awarded fourteenth prize for production, June 23-30, 1903, 19.493 lbs. butter fat.
[3] Production during 19 days, April 8-26, '04: 1,330.7 lbs. milk, 51.603 lbs. fat, average per cent, 3.88; awarded fifteenth prize.
[4] Production during 14 days, May 7-21, '04: 1,331.0 lbs. milk, 40.272 lbs. fat, average per cent, 3.03; awarded seventh prize.

29	Grace Fayne 2d	44124	Apr. 20	7— 2—25	25	569.0	20.335	3.59	3.0 - 4.2	2.609-3.184	102.8	102.5-3.2
29	Grace Fayne 2d	44124	May 7	7— 2—25	42	677.0	21.037	3.11	2.65- 3.5	2.936-3.037	101.9	101.6-2.2
30	Lady Longfield 4th[1]	44125	Apr. 12	7— 1—21	24	526.5	19.305	3.64	2.4 - 4.8	2.385-3.195	102.2	102.0-2.4
31	Lady Oak Fern	44126	Feb. 11	6—11— 9	13	423.9	16.391	3.84	3.2 - 4.6	2.170-2.548	101.5	101.2-2.1
31	Lady Oak Fern	44126	Mar. 15	6—11— 9	46	436.9	17.445	3.99	3.1 - 4.8	2.386-2.674	....	....
32	Jessie Fobes 2d Tritonia[2]	44130	Apr. 18	7— 3— 5	17	529.2	19.289	3.69	3.2 - 4.0	2.598-2.909	102.3	102.0-3.0
33	Blanche Frisby	44132	Apr. 2	7— 1— 8	17	462.5	15.901	3.42	2.95- 4.0	2.145-2.379	102.1	101.9-2.3
34	Maggie of Wild Rose 2d	44974	May 26	6—11—29	27	460.6	14.912	3.23	2.7 - 4.0	1.975-2.399	101.7	101.2-2.1
35	Madrigal Netherland Pet[3]	45150	Mar. 10	6— 8— 8	10	467.6	19.894	4.25	2.4 - 5.75	2.388-3.564	102.0	101.9-2.1
36	Birdie Pietertje	45943	June 11	7— 8—20	12	352.5	12.327	3.50	2.75- 4.4	1.414-2.020	101.8	101.4-2.2
37	Johanna Rue 4th	45166	Dec. 26	6— 1—29	36	480.7	15.335	3.19	2.05- 4.3	1.966-2.381	....	....
38	Skylark Hendrika	46154	Feb. 25	6— 8—25	32	418.1	14.309	3.42	2.9 - 4.1	1.954-2.102	102.0	....
39	Frances Colanthus	46629	Mar. 26	8— 4—29	12	505.5	17.051	3.37	2.75- 4.4	2.331-2.621	102.3	101.6-3.0
40	Aaltje Salo Augusta 2d	46798	Feb. 3	6— 0—28	79	433.4	12.985	3.00	2.0 - 4.3	1.758-2.001	102.0	101.1-2.8
41	Pietertje Echo De Kol	46977	Feb. 9	6— 1—14	60	342.3	12.597	3.68	3.25- 4.4	1.741-1.891	....	....
42	Katydid of Meadow Lawn	47147	Dec. 10	7— 0—16	9	436.3	14.775	3.39	2.8 - 4.4	1.943-2.221	102.4	101.8-2.8
43	Ruby B.	47617	Nov. 15	5— 8—28	23	372.4	14.092	3.78	3.4 - 4.3	1.901-2.112	....	....
44	Duchess Ormsby 2d's Queen[4]	48317	Mar. 28	5— 6—26	7	384.9	18.396	4.78	3.0 -10.5	2.310-3.926	....	....
45	Duchess Ormsby 4th[5]	48504	Mar. 24	5— 2—21	7	412.0	16.844	4.08	3.1 - 6.0	2.292-2.492	....	....
45	Duchess Ormsby 4th	48504	Apr. 14	5— 2—21	28	395.1	13.952	5.53	2.5 - 4.2	1.877-2.115	....	....
46	Theresa De Kol	48843	Apr. 3	5— 9—13	7	430.7	15.681	3.64	2.6 - 5.0	2.205-2.351	102.8	102.6-3.0
47	Lucy De Kol	48997	Apr. 4	5—10— 5	10	469.3	14.763	3.15	2.3 - 4.7	2.012-2.331	102.7	102.2-3.2
48	Duchess Ormsby 3d Butter Girl	49079	Mar. 20	6— 6—10	8	309.8	16.467	5.32	4.58- 6.2	2.160-2.676	101.3	101.0-1.6
49	Houwtje F. 2d	49130	Mar. 21	5— 3—10	23	430.7	13.638	3.18	2.8 - 3.6	1.869-2.118	101.8	101.7-1.9
50	Days Blue Bell	49132	Mar. 21	5— 6— 6	19	346.2	13.133	3.78	2.1 - 5.9	1.379-2.376	101.6	101.5-1.7
51	Aaltje Salo Reka	49337	Apr. 6	5— 2—25	45	460.6	15.385	3.33	2.5 - 4.8	1.977-2.631	....	....
51	Aaltje Salo Reka	49337	Apr. 14	5— 2—25	53	492.7	14.496	2.94	2.25- 4.0	1.845-2.346	....	....
52	Sissy Pietertje De Kol Ringwood	49421	Dec 27	5— 1— 6	11	335.4	12.146	3.62	2.85- 4.5	1.606-1,854	102.0	101.6-2.4
53	Princess Jewel of Home Farm	49598	Mar. 16	5— 2— 9	9	282.0	9.796	3.50	1.93- 4.75	.955-1.707	101.2	100.8-1.5
54	Juma Girl Echo	49653	May 26	5— 7—17	14	480.4	18.227	3.79	3.25- 4.3	2.390-2.816	101.8	101.2-2.3
55	May Melchior 2d	49770	Mar. 16	5— 4—28	11	309.0	11.563	3.73	3.2 - 4.3	1.564-1.886	101.3	101.0-1.9
56	Nellie Wa Wa 2d	49771	Apr. 20	5— 5—26	15	346.0	11.876	3.43	3.15- 4.0	1.663-1.788	101.5	101.3-1.9
57	Leland Pride Echo	49857	Nov. 16	5— 1—29	16	351.9	13.713	3.89	3.5 - 4.2	1.831-2.158	....	....
58	Belle Terzol Mechthilde	50119	Dec. 1	6— 4—26	15	440.6	17.643	4.00	3.5 - 4.4	2.400-2.622	....	....
59	Shadeland Mechthilde	50187	June 22	7— 1—24	61	436.3	14.687	3.37	2.45- 4.55	1.926-2.169	100.6	100.6-0.6
60	Aaggie Bell Netherland	50623	Mar. 8	5— 0—13	8	465.2	13.770	2.96	1.8 - 4.05	1.918-2.039	102.2	101.7-2.7
61	Liscomb Aaggie 4th	51178	Mar. 27	5— 1— 8	7	352.3	13.752	3.90	2.2 - 5.8	1.789-2.116	....	....
62	Mechthilde of Monticello	51217	Jan. 9	5— 8—13	8	355.7	12.204	3.43	2.55- 4.25	1.663-1.891	102.1	101.3-2.8
63	Aurora 4th	51787	Feb. 5	7— 4—22	9	293.1	12.004	4.10	3.1 - 4.8	1.625-1.781	102.1	101.6-2.6
64	Indi W's Pride	54595	Feb 26	8— 0—14	11	354.6	11.380	3.21	2.7 - 3.85	1.531-1.767	....	....
65	Aaggie Lotta 3d Emma	54593	Apr. 16	8— 3—25	20	354.6	9.873	2.78	2.0 - 3.75	1.247-1.648	....	....

[1] Production during 14 days, April 11-24, '04: 952.0 lbs. milk, 35.835 lbs. fat; average per cent, 3.76.
[2] Production during 14 days, April 17-30, '04: 1,085.9 lbs. milk, 37.677 lbs. fat, average per cent, 3.47; awarded twelfth prize.
[3] Awarded tenth prize.
[4] Awarded nineteenth prize.
[5] Production during 28 days, March 23-April 20, '04: 1,574.5 lbs. milk, 57.874 lbs. fat, average per cent, 3.67.

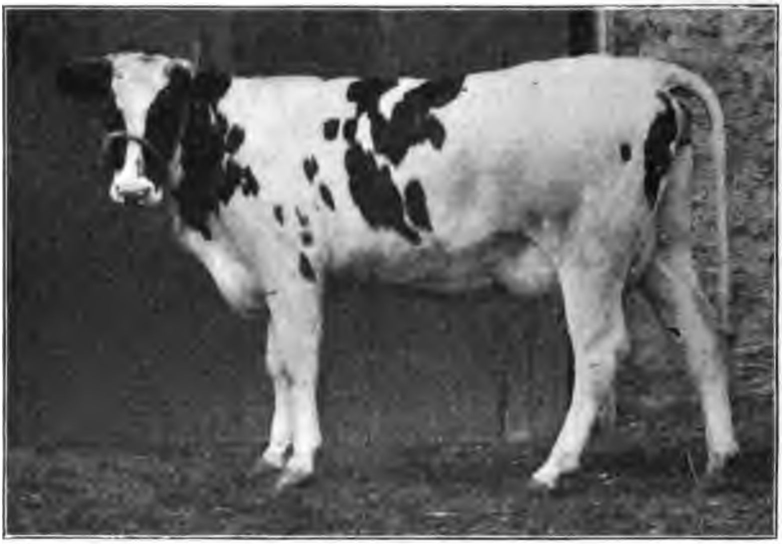


FIG. 23.—Alice De Kol Wayne of Lake Side (No. 61625, H.-F. H. B.), owned by Wm. Everson & Sons, Lake Mills, Wis. Production during 7 days, 391.7 lbs. milk, 12.538 lbs. fat; average per cent. fat, 3.20.

FIG. 24.—Canary Mercedes Victoria (No. 43780, H.-F. H. B.), owned by Wm. Everson & Sons, Lake Mills, Wis. Production during 7 days, 482.2 lbs. milk, 16.586 lbs. fat; average per cent. fat, 3.44.

FIG. 25.—Ava Colanthus Piebe (No. 61971, H.-F. H. B.), owned by F. B. Fargo, Lake Mills, Wis. Production during 7 days, 338.9 lbs. milk, 14.188 lbs. fat; average per cent. fat, 4.19. Awarded first prize in class 7, H.-F. Asso., 1903-4; also third prize for 30-day record, 1903-4, 1,380.3 lbs. milk, 54.436 lbs. fat; average per cent. fat, 3.94.

FIG. 26.—De Kol Douglas (No. 50667, H.-F. H. B.), owned by E. E. Randall, Watertown, Wis. Production during 7 days, 480.8 lbs. milk, 18,732 lbs. fat; average per cent. fat, 3.90. Awarded first prize in class 4, H.-F. Asso., 1903-4; also first prize for 30-day record, 1903-4, 1,992.7 lbs. milk, 74.003 lbs. fat; average per cent. fat, 3.71.

Official tests of Holstein cows, 1903–1904—Continued.

Cow No.	Name of Cow.	Herd book No.	Test began	Age.	Days in milk.	Yield in Seven Days. Milk.	Yield in Seven Days. Fat.	Per Cent Fat. Ave.	Per Cent Fat. Range.	Fat per Day. Range.	Temperature of Cow. Ave.	Temperature of Cow. Range.
				Y. M. D.		Lbs.	Lbs.	Pr ct.	Pr ct.	Lbs.	°F.	°F.
	Class I—Cows five years old or over. (Continued.)											
66	Lilian Lansing	54596	Apr. 30	5—10—14	7	314.5	10.420	3.31	2.05- 5.45	1.165-1.780	....	....
67	Lady Indi	55030	May 10	7— 2— 3	7	337.0	12.486	3.71	3.0 - 4.65	1.598-2.020	....	....
68	Silver Josephine	69724	Mar. 5	5— 8—12	13	337.9	13.929	4.12	2.3 - 7.4	1.754-2.219	102.1	102.1-2.3
	Average for 74 tests (68 different cows)	....	....	....	**22**	**414.0**	**14.816**	**3.58**	1.8 - 7.75	.955-3.926	**102.0**	100.0-4.8
	Class II—Cows four years old and under five.											
69	Romana Queen De Kol	48522	Oct 20	4—10—14	26	336.9	10.617	3.15	2.6 - 3.7	1.283-1.636	102.2	102.0-2.4
70	Colantha 4th's Johanna	48577	June 28	4— 7—20	375	353.8	12.292	3.47	2.7 - 4.7	1.574-2.060	....	....
71	Virginne Pietertje 2d	49968	May 12	4—11—21	24	465.9	13.002	2.81	2.0 - 4.35	1.708-2.037	102.2	102.0-2.5
72	Ida Lotta	50027	Nov. 4	4— 6—25	38	380.3	12.157	3.20	2.1 - 4.3	1.584-1.880	101.9	101.8-1.9
73	Piebe Pauline De Kol	50434	Nov. 9	4— 8—28	42	307.1	9.785	3.19	2.35- 3.95	1.301-1.448	100.7	100.6-0.7
74	Jessie Griepe 2d	50668	Oct. 16	4— 4—24	33	326.8	11.610	3.55	3.05- 4.1	1.567-1.780	....	....
75	Gewina 2d's Lilly 2d	50670	Oct. 16	4— 4— 4	22	364.3	13.168	3.61	2.8 - 4.35	1.764-1.993	101.7	101.7-1.8
75	Gewina 2d's Lilly 2d	50670	June 18	4— 4— 4	268	303.9	11.498	3.78	3.2 - 4.3	1.580-1.680	....	....
76	Heilo Aaggie Johanna 2d	50799	Oct. 16	4— 3—25	15	385.5	14.774	3.83	3.1 - 4.65	1.988-2.175	102.1	102.1-2.4
76	Heilo Aaggie Johanna 2d	50799	June 18	4— 3—25	260	297.9	10.705	3.60	2.4 - 5.0	1.477-1.586	....	... .
77	Orleans De Kol Pauline	51080	Nov. 9	4— 7— 2	30	323.3	11.315	3.50	2.8 - 4.5	1.475-1.761	101.2	100.7-1.8
78	Pietertje Maid of Grouw 2d	51194	Nov. 18	4— 9— 1	11	338.9	13.081	3.86	3.3 - 4.2	1.811-1.929	102.0	101.6-2.3
79	Oak De Kol	51297	Oct. 31	4— 7—21	30	381.2	15.290	4.01	3.1 - 4.8	1.984-2.368	103.2	102.7-3.8
80	Rena Myrtle De Kol	51298	Nov. 6	4— 8— 0	29	371.9	12.598	3.39	2.8 - 5.15	1.625-1.984	102.5	102.0-3.0
81	Jessie Fobes 6th's Violet	52118	Apr. 2	4—10—28	25	436.5	13.580	3.10	2.4 - 4.4	1.807-2.047	102.2	102.1-2.3
82	Duchess Ormsby 5th	52151	Mar 20	4— 2—12	21	350.4	12.655	3.61	2.65- 5.4	1.575-2.033	101.5	101.0-2.0
83	Johanna De Pauline 3d	52254	June 28	4— 6—11	20	429.6	13.784	3.21	2.65- 3.75	1.919-2.027	....	....
84	De Kol Snowflake	52335	Jan. 23	4— 2— 4	9	334.6	12.186	3.64	2.7 - 4.4	1.613-1.862	101.8	101.6-2.0
85	De Kol Longfield[1]	52505	July 6	4—10—10	31	436.3	14.524	3.33	1.9 - 5.7	1.789-2.553	101.6	101.2-1.9
86	Lady Ruiter Zida	52543	Jan. 5	4— 2—17	24	435.3	13.969	3.21	2.45- 4.45	1.674-2.078	102.1	101.6-2.6
87	Mechthilde Daisy Checkers[2]	52549	Feb 13	4— 1— 3	24	395.8	15.892	4.02	3.6 - 4.8	2.211-2.330	....	....
88	Hengerveld De Kol Tritomia	53078	Mar. 31	4— 4—20	19	309.6	11.438	3.69	2.75- 5.2	1.561-1.704	....	....

[1] Production during 14 days, June 29–July 12, '04: 875.1 lbs. milk, 27.107 lbs. fat; av. per cent, 3.10.
[2] Awarded ninth prize.

89	Aaltje Nettie 2d	53134	Feb. 3	4— 3—20	12	288.0	11.449	3.98	2.55- 6.0	1.468-1.874	101.9	101.7-2.1
90	Jewel Maid Mercedes	53249	Nov. 16	4— 0—13	27	373.1	12.685	3.40	3.0 - 3.7	1.704-1.898	....	....
91	Katie Jewel Mercedes	53252	Dec. 13	4— 2— 5	21	420.3	15.255	3.63	3.3 - 4.6	2.083-2.270	101.3	100.4-2.1
92	Canary's Mercedes Fillpale [1]	53353	Dec. 4	4— 1—25	7	408.4	16.052	3.93	3.0 - 5.0	2.131-2.396	102.0	101.4-2.6
93	Daisy A Mercedes 4th's De Kol	53641	Feb. 26	4— 3—10	19	429.5	13.330	3.10	2.75- 3.85	1.821-2.029	102.0	101.8-2.2
94	Daisy Mercedes Pietertje 2d	53643	Jan. 5	4— 2— 1	11	423.3	13.700	3.23	2.9 - 3.6	1.870-2.031	101.6	101.0-2.0
95	Skylark Mercedes De Kol [2]	53644	Dec. 13	4— 1—18	10	452.9	18.135	4.00	3.75- 4.5	2.497-2.625	102.2	101.8-2.6
96	Netta Pauline De Kol [3]	53850	Mar. 25	4— 3—20	7	397.5	12.370	3.11	2.45- 3.85	1.618-1.904	....	....
97	Liscomb Aaggie 5th	54123	Apr. 14	4— 3— 8	6	349.9	10.997	3.14	2.15- 4.5	1.513-1.668	101.5	101.1-1.9
98	Clothilde De Vries De Kol	54599	Feb. 19	4— 1— 0	16	305.3	9.622	3.12	2.55- 3.95	1.337-1.419	....	....
99	Edith Turlington 3d's Pauline	54600	Jan. 26	4— 7—28	111	284.7	9.669	3.40	3.25- 3.7	1.375-1.395	....	....
100	Duchess De Dikkert	54602	May 7	4— 4—17	7	303.7	13.063	4.31	3.2 - 5.3	1.646-2.158	....	....
101	Alma Marie Josephine	54846	Dec. 13	4— 3—18	12	391.0	15.681	4.11	3.25- 5.15	2.181-2.290	102.3	102.2-2.4
101	Alma Marie Josephine [4]	54846	Jan. 8	4— 3—18	38	442.3	16.419	3.71	2.9 - 4.8	2.145-2.586	102.0	101.8-2.2
101	Alma Marie Josephine	54846	Aug. 3	4— 3—18	246	164.8	5.554	3.37	3.05- 3.85	.729- .844	....	....
102	Aaggie Emma De Kol	59598	May 14	4— 3—14	11	306.3	10.950	3.57	3.0 - 4.3	1.134-1.698	....	....
103	Aaggie Lillian	59600	Apr. 15	4— 2—19	10	262.8	9.052	3.44	3.0 - 4.2	1.235-1.404	....	....
104	Indi Hinton	59603	Jan. 27	4—10—11	7	366.6	13.264	3.62	3.15- 4.05	1.746-1.966	....	....
104	Indi Hinton	59603	Feb. 10	4—10—11	21	422.7	12.606	2.98	2.7 - 3.4	1.709-1.918	....	....
	Average for 41 tests (36 different cows)	....	....	....	**48**	**362.4**	**12.677**	**3.50**	1.9 - 6.0	1.134-2.625	**101.9**	100.4-3.8
	Class III—Cows three years old and under four.											
105	Daisy A. Mercedes 5th	53642	Nov. 13	3—11—24	22	388.4	14,690	3.79	3.25- 4.95	1.988-2.158	102.0	101.6-2.4
106	Pietertje Maid of Grouw 3d	53646	Nov. 23	3— 9—30	8	359.8	13.696	3.81	3.3 - 4.9	1.881-2.024	102.3	102.0-2.6
107	Piebe 5ths De Kol	53725	Feb. 3	3— 8— 3	36	348.1	10.442	3.00	2.15- 4.0	1.360-1.644	102.0	101.4-2.7
108	Aaggie Stafford	54871	Mar. 14	3— 9—28	6	343.7	9.998	3.18	2.3 - 4.3	1.301-1.581	102.5	102.0-3.0
109	Gewina Beauty Bell 2d	55015	Oct. 16	3— 6— 2	22	236.2	9.505	4.02	3.45- 5.15	1.277-1.426	....	....
110	Wisconsin Bess 3d	55018	Oct. 16	3— 3—10	7	303.1	11.717	3.87	3.25- 4.4	1.547-1.880	....	....
111	Heilo Aaggie Johanna 3d	55020	Oct. 16	3— 2—13	6	318.5	12.192	3.83	3.2 - 4.55	1.655-1.843	....	....
112	Artis R. De Kol	55029	Feb. 6	3— 9—17	7	293.3	11.040	3.76	2.6 - 7.3	1.246-2.677	101.9	101.6-2.0
113	Queen Ringwood's 2ds Johanna	55034	May 10	3— 8—29	10	273.7	11.209	4.09	3.0 - 6.05	1.402-1.769	101.9	101.6-2.2
114	Aaggie Night	55991	Dec. 29	3— 2—13	11	322.7	12.254	3.80	2.15- 6.6	1.684-1.833	102.3	101.4-3.4
115	Dalinda Elbaje	56313	June 3	3— 6—13	14	293.1	10.660	3.64	2.6 - 5.0	1.397-1.681	....	....
116	Miss Longfield	57106	Nov. 16	3— 0—18	15	273.1	10.831	3.96	3.5 - 4.4	1.465-1.694	....	....
117	Frances De Kol of Lakeside	57206	Feb. 27	3— 4—29	13	346.6	11.267	3.25	2.25- 4.5	1.347-1.760	102.6	102.5-2.6
118	Canary Mercedes Victoria 2d	57257	Jan. 18	3— 2—11	39	298.5	9.594	3.22	2.75- 3.65	1.273-1.447	102.3	101.6-2.7
119	Cherry Duchess 2ds Lady Burke	57275	Feb. 12	3— 2—21	42	268.8	9.313	3.47	2.6 - 3.8	1.274-1.406	101.2	101.0-1.6
120	Aaggie Ruth	57392	Feb. 3	3— 2—10	32	330.6	9.940	3.01	2.25- 3.55	1.261-1.554	101.8	101.4-2.1

[1] Awarded seventh prize.
[2] Awarded third prize.
[3] Production during 14 days, March 24-April 6, '04: 810.1 lbs. milk, 24.475 lbs. fat; av. per cent, 3.02.
[4] Awarded fifth prize.

FIG. 27.—Allie Nig (No. 59170, H.-F. H. B.), owned by E. E. Randall. Watertown, Wis. Production during 7 days, 367.6 lbs. milk, 13.839 lbs. fat; average per cent. fat, 3.76. Awarded third prize in class 7, H.-F. Asso., 1903-4; also fifth prize for 30-day record, 1903-4, 1,387.2 lbs. milk, 51.698 lbs. fat; average per cent. fat, 3.73.

FIG. 28.—Winnie Wartena Netherland (No. 37630, H.-F. H. B.), owned by Reddelien Bros., North Lake, Wis. Production during 7 days, May, 1904, 535.7 lbs. milk, 21.419 lbs. fat; average per cent. fat, 4.00. Awarded fourteenth prize in class 1, H.-F. Asso., 1903-4, for production, June 23-30, 1903, 19.493 lbs. butter fat.

FIG. 29.—Netherland Bessie (No. 35997 H.-F. H. B.), owned by C. A. Schroeder, West Bend, Wis. Production during 7 days, 528.3 lbs. milk, 19.974 lbs. fat; average per cent. fat, 3.78. Awarded ninth prize in class 1, H.-F. Asso., 1903-4; also second prize for 30-day record, 1903-4, 2,185.4 lbs. milk, 83.897 lbs. fat; average per cent. fat, 3.84.

FIG. 30.—Netherland Johanna De Kol 2nd (No. 61871, H.-F. H. B.), owned by C. A. Schroeder, West Bend, Wis. Production during 7 days, 362.4 lbs. milk, 12.918 lbs. fat; average per cent. fat, 3.56. Awarded fifth prize in class 7, H.-F. Asso., 1903-4; also fourth prize for 30-day record, 1903-4, 1,537.0 lbs. milk, 52.521 lbs. fat; average per cent. fat, 3.42.

Official tests of Holstein cows, 1903–1904—Continued.

Cow No.	Name of Cow.	Herd book No.	Test began.	Age.	Days in milk.	Yield in Seven Days. Milk.	Yield in Seven Days. Fat.	Per Cent Fat. Ave.	Per Cent Fat. Range.	Fat Per Day. Range.	Temperature of Cows. Ave.	Temperature of Cows. Range.
	Class III—Cows three years old and under four—Continued.			Y. M. D.		Lbs.	Lbs.	Pr ct.	Pr ct.	Lbs.	°F	°F.
121	Gracie De Kol [1]	57763	Jan. 3	3—1—13	20	506.4	15.801	3.12	2.7 - 3.4	2.101-2.360	102.3	102.2-2.4
122	Daisy Mercedes Pietertje 3d	57764	Jan. 5	3—1—8	9	362.6	11.525	3.18	2.0 - 3.8	1.472-1.795	101.7	102.2-2.6
123	Duchess Hengerveld De Kol	58178	Apr. 27	3—1—26	12	322.8	13.693	4.25	2.35- 7.3	1.695-2.217	101.6	101.1-2.1
124	Dora Ormsby	58464	May 1	3—0—2	16	356.5	11.579	3.25	2.25- 4.35	1.543-1.725	....	....
125	Parthenea Tirania Mechthilde	58473	Mar. 8	3—6—0	17	393.3	13.617	3.46	2.3 - 5.8	1.719-1.931	102.1	102.0-2.2
126	Gertrude Jess De Kol	58516	June 11	3—4—5	22	359.0	12.423	3.46	2.6 - 4.4	1.605-1.961	101.5	101.0-2.2
127	Johanna Rue De Kol	58549	May 26	3—0—13	14	436.6	14.426	3.30	2.7 - 4.1	1.631-2.426	101.8	101.3-2.4
128	Alcartra Plum	59075	May 5	3—0—3	21	384.6	14.048	3.65	2.85- 4.1	1.931-2.048	101.7	101.6-1.8
129	Snowball Pink	59077	June 18	3—2—29	15	356.7	13.042	3.60	2.9 - 4.7	1.806-1.917	....	....
130	Jessie Griepe 4th	59078	May 25	3—0—3	58	351.1	11.709	3.33	3.0 - 3.7	1.640-1.710	101.9	101.5-2.3
131	Wisconsin Bess 4th	59175	June 18	3—1—0	12	352.5	11.709	3.32	2.1 - 4.2	1.539-1.760	....	....
132	Ollie Watson 5th's Pearl	59175	June 18	3—2—3	7	322.1	10.428	3.24	2.6 - 3.9	1.356-1.591	....	....
133	Canary Longfield [2]	59190	June 29	3—1—3	16	328.0	13.819	4.21	3.5 - 4.9	1.775-2.086	....	....
134	Princess Surprise De Kol	59601	Feb. 26	3—4—10	9	321.7	10.458	3.25	2.8 - 3.7	1.405-1.621	102.0	102.0-2.0
135	Rigtje De Kol Pauline	62290	Jan. 27	3—2—21	9	296.2	10.872	3.67	3.1 - 4.3	1.503-1.619	102.0	101.6-2.4
136	Kornelis De Kol	62296	Mar. 31	3—6—0	11	370.9	13.902	3.75	2.8 - 5.6	1.811-2.164	103.1	102.6-3.6
137	Tirania Vickery Mechthilde	69649	Apr. 8	3—11—11	19	399.7	11.710	2.93	2.0 - 4.6	1.471-1.955	100.9	100.3-2.2
138	Martha Elgin Butter Girl De Kol	70783	May 17	3—0—8	11	392.8	11.847	3.01	2.2 - 3.8	1.611-1.766	102.1	102.0-2.3
	Average of 34 tests (34 different cows)	......	....	....	**17**	**340.6**	**11.915**	**3.50**	2.0 - 7.3	1.246-2.677	**102.0**	100.3-3.6
	Class IV—Cows two years old and under three.											
139	Netherland Netta De Kol 2d	54778	Dec. 15	2—10—4	9	300.7	10.777	3.58	3.1 - 4.5	1.485-1.594	101.7	101.8-2.2
140	Leola Bell De Kol	56381	Jan. 25	2—7—0	36	233.7	7.624	3.26	2.6 - 3.8	.930-1.233	102.4	101.8-3.0
141	Lost Wonder Piebe	56944	Oct. 31	2—11—22	43	389.0	12.138	3.13	2.5 - 4.4	1.651-1.849	102.5	102.3-2.8
142	Bessie Ward Tritomia Piebe	56946	Oct. 31	2—11—21	40	355.4	12.857	3.62	3.0 - 4.5	1.780-1.915	103.4	102.8-3.9
143	Fannie Bell	57273	Nov. 9	2—11—16	30	227.5	8.266	3.63	3.05- 4.1	1.130-1.217	101.8	101.5-2.3
144	Aaltje Salo 5th's Netherland 2d	57390	Oct. 10	2—10—27	17	268.5	9.285	3.46	2.85- 4.65	1.197-1.495	102.7	102.3-3.0

[1] Awarded fourth prize.
[2] Production during 14 days, June 24–July 7, '04: 633.5 lbs. milk, 27.125 lbs. fat; average per cent., 4.30.

145	Aaggie Ruth	57392	Nov. 4	2—2—14	302	185.6	5.780	3.11	2.5 - 3.7	.670- .958	102.2	101.6-2.6
146	Skylark M. De Kol	57761	Dec 2	2—10—21	8	356.5	13.632	3.82	3.0 - 4.3	1.861-2.008	102.6	102.2-3.0
147	Aaggie De Kol 3d	57796	Feb. 11	2—7—14	150	287.4	10.017	3.48	3.15- 3.8	1.364-1.495	...	....
148	Jessie Parthenea Johanna	58180	Mar. 5	2—11—15	11	279.4	10.288	3.68	2.75- 8.0	1.269-1.672	101.9	101.8-2.0
149	Flora Belle Pietertje 2d	58184	Oct. 30	2—3—15	13	287.0	8.051	2.80	1.9 - 4.4	1.090-1.238	102.2	101.8-2.6
150	Aaltje Salo Princess Paula	58352	Nov. 4	2—4—3	64	248.4	7.376	2.97	1.95- 4.05	.902-1.166	102.1	101.9-2.5
151	Beatrice Ormsby	58465	Apr. 2	2—11—16	35	308.1	12.484	4.05	2.35- 6.3	1.594-1.943	....	....
152	Maud Piebe Pauline	58515	Feb. 8	2—11—20	7	325.5	10.880	3.33	2.5 - 4.6	1.479-1.718	....	....
152	Maud Piebe Pauline	52515	Feb. 12	2—11—20	11	339.5	12.516	3.68	3.0 - 4.6	1.712-1.850	102.0	101.0-2.6
153	Lady Oak 2d's Piebe De Kol[1]	58644	Apr. 10	2—11—16	30	399.5	14.911	3.70	3.0 - 4.6	1.906-2.233	102.0	101.7-2.3
154	Snowball Pink	59077	Oct. 16	2—4—8	96	197.2	7.941	4.03	3.65- 4.65	1.064-1.173	....	....
155	Heilo Aaggie Diploma	59171	Jan. 26	2—3—18	42	255.7	9.032	3.53	2.4 - 4.7	1.168-1.405	103.0	103.0-3.0
156	Heilo Aaggie Johanna 4th	59176	Jan. 26	2—5—18	10	275.2	10.661	3.87	2.65- 5.4	1.404-1.742	102.4	102.4-2.4
157	Lilly Gewina	59178	June 18	2—4—3	224	287.5	9.364	3.26	2.7 - 4.0	1.313-1.371	....	....
158	Canary Longfield	59190	Dec. 18	2—3—13	117	241.2	8.357	3.46	3.05- 4.15	1.126-1.228	101.3	100.8-1.8
159	Lady Longfield 2d's Night	59192	June 21	2—10—15	28	388.1	13.139	3.39	2.0 - 5.9	1.638-2.289	101.0	101.0-1.0
160	Mazie Johanna	59194	Jan. 1	2—1—11	30	314.0	9.970	3.18	2.00- 5.25	1.268-1.676	102.1	102.0-2.6
160	Mazie Johanna	59194	Dec. 18	2—1—11	16	309.2	8.676	2.81	1.7 - 4.4	1.194-1.301	102.3	102.0-2.4
161	Nina Duchess Melchior	59195	June 19	2—8—29	43	352.8	10.218	2.90	2.2 - 4.3	1.364-1.550	....	....
162	Netherland Artis Mechthilde	59609	Dec. 13	2—2—22	8	249.9	10.486	4.16	3.3 - 5.55	1.424-1.579	102.8	102.2-3.2
162	Netherland Artis Mechthilde	59609	Aug. 5	2—2—22	244	132.9	4.979	3.75	3.5 - 4.05	.678- .739	....	....
163	Josephine De Kol Pietertje	59608	Aug. 3	2—1—12	320	162.9	5.333	3.27	2.9 - 3.7	.734- .795	....	....
164	Ruby Hengerveld De Kol	59727	Apr. 24	2—1—11	16	295.8	9.774	3.30	2.5 - 4.45	1.323-1.472	101.7	101.0-2.5
165	Theresa De Kol Beauty	60091	Apr 16	2—11—9	8	342.4	10.915	3.19	2.9 - 3.6	1.520-1.623	102.9	102.8-3.2
166	Elgin Mercedes Butter Queen	60188	Feb. 9	2—7—7	11	266.2	10.230	3.84	2.5 - 5.5	1.311-1.641	102.5	102.0-3.0
167	Colantha 4th's Lass[2]	60984	Dec. 29	2—1—6	20	341.7	11.762	3.44	1.8 - 5.25	1.315-1.956	....	....
168	Johanna De Kol 4th	60985	Dec. 28	2—0—29	35	291.1	9.895	3.39	2.15- 4.4	1.338-1.469	....	....
169	Johanna Clothilde 4th	60986	Jan. 4	2—1—17	10	276.7	11.639	4.20	2.6 - 6.0	1.478-1.937	....	....
170	Johanna Bonheur	60987	Dec. 31	2—1—26	22	344.6	11.353	3.30	2.6 - 3.9	1.534-1.702	....	....
171	Johanna Rosa	60993	Jan. 3	2—1—8	37	294.8	9.797	3.31	2.9 - 3.7	1.301-1.528	....	....
172	Veronica De Kol of Lake Side	61736	Mar. 26	2—0—9	7	294.0	9.847	3.35	2.65- 4.5	1.323-1.523	102.3	102.2-2.4
172a	Netherland Johanna De Kol 2d[3]	61871	Apr. 16	2—4—3	41	362.4	12.918	3.56	2.6 - 5.0	....	....	....
173	Ava Terzool Homestead De Kol	61967	Mar. 3	2—2—7	28	251.9	8.853	3.51	2.6 - 4.5	1.166-1.301	102.3	102.0-2.6
173a	Ava Colanthus Piebe[4]	61971	Mar. 21	2—3—1	16	338.9	14.188	4.19	2.2 - 6.05	....	....	....
174	Grace Burke	62063	Feb. 11	2—1—8	34	186.3	7.815	4.20	2.95- 5.6	1.010-1.313	101.9	101.6-2.6
175	Jennie Pauline Burke	62064	Apr. 4	2—3—10	26	278.2	9.567	3.40	2.8 - 4.0	1.317-1.389	....	....
176	Jessie Fobes Helena	62118	May 25	2—5—28	58	297.7	10.094	3.36	2.8 - 4.1	1.346-1.579	101.9	101.4-2.3
177	Madge Mercedes Pietertje 3d	62228	Mar. 2	2—2—8	9	270.1	9.259	3.43	2.5 - 4.9	1.157-1.540	103.6	102.6-4.6
178	Daisy B. M. De Kol[5]	62232	Nov. 26	2—0—22	8	282.4	11.945	4.23	3.65- 4.75	1.684-1.734	102.4	101.8-3.0
179	Daisy Mercedes Pietertje 4th	62236	Mar. 9	2—3—18	14	384.7	10.407	2.71	1.9 - 4.0	1.316-1.507	103.1	102.2-4.0
180	Tritomia Ormsby	62359	June 7	2—3—5	10	296.7	9.074	3.06	2.4 - 3.8	1.213-1.381	102.6	102.2-3.0
181	Bakker Belle Pietertje 2nd	62361	Mar. 16	2—1—23	11	300.4	11.025	3.72	2.6 - 4.9	1.352-1.982	101.1	100.7-1.6

[1] Awarded third prize.
[2] Awarded eleventh prize.
[3] Awarded fifth prize.
[4] Awarded first prize.
[5] Awarded tenth prize.

Official tests of Holstein cows, 1903-1904—Continued.

Cow No.	Name of Cow.	Herd book No.	Test began	Age.	Days in milk.	Yield in Seven Days. Milk.	Yield in Seven Days. Fat.	Per Cent Fat. Ave.	Per Cent Fat. Range.	Fat Per Day. Range.	Temperature of Cows. Ave.	Temperature of Cows. Range.
	Class IV—Cows two years old and under three.			Y. M. D.		Lbs.	Lbs.	Pr ct.	Pr ct.	Lbs.	°F.	°F.
181	Bakker Belle Pietertje 2nd	62361	Mar. 23	2—1—23	18	284.3	9.250	3.15	2.2 - 4.0	1.233-1.535	101.0	101.2-1.4
182	Gem Bakker De Kol	62363	Apr. 16	2—5—20	6	253.3	8.874	3.50	2.7 - 4.7	1.147-1.385	101.8	101.6-2.0
183	Jessie Fobes Myrtle Piebe[1]	62889	Apr. 24	2—0—29	11	394.0	10.289	2.60	2.3 - 3.6	1.414-1.525	102.2	102.0-2.3
184	Glen De Kol Artis 2d	62892	May 14	2—2—20	13	269.9	8.303	3.08	2.5 - 3.6	1.088-1.281	102.2	102.0-2.4
185	Jessie Fobes 7th	62893	May 14	2—2—13	11	347.7	10.190	2.93	2.0 - 3.8	1.371-1.550	102.5	102.0-3.0
186	Liscomb Aaggie Colantha	63183	May 8	2—2—15	11	288.3	8.961	3.11	1.65- 4.9	1.127-1.402	101.8	101.6-2.0
187	Wisconsin Bess 5th	63561	May 5	2—0—17	26	306.2	10.631	3.47	2.6 - 4.25	1.284-1.676	102.0	101.6-2.4
188	Francktje 2d's Maid 2d	63565	May 3	2—0—11	35	306.1	10.275	3.36	2.7 - 4.05	1.369-1.565	102.0	101.8-2.2
189	Lucy Watson	63566	May 25	2—2—22	13	272.3	9.766	3.58	3.1 - 4.1	1.264-1.512	101.2	100.7-1.5
190	Fyke Mechthilde 3d	63966	Apr. 19	2—0—14	7	234.7	8.883	3.78	3.0 - 5.05	1.145-1.392	101.7	101.5-2.1
191	Daisy Wit Barbetta	64175	June 30	2—0—16	24	246.0	8.173	3.32	2.4 - 4.6	1.091-1.224	....	....
192	Lady Ormsby	64352	June 12	2—2—1	23	325.9	11.550	3.54	2.4 - 5.2	1.434-1.892	101.5	100.8-2.2
193	Rixa Ormsby	64349	May 30	2—2—22	10	258.9	10.156	3.92	2.7 - 5.4	1.222-1.597	102.0	101.6-2.4
194	Frankie Ormsby	64354	May 24	2—2—7	16	314.4	10.078	3.21	2.6 - 4.3	1.373-1.519	101.9	101.6-2.2
195	Piebe Laura Gem[2]	64355	Mar. 14	2—0—9	12	263.0	11.527	4.38	3.45- 5.8	1.530-1.761	102.4	101.7-2.8
196	Johanna Beechwood	65954	May 23	2—9—8	254	250.6	8.794	3.51	3.4 - 3.7	1.170-1.348	....	....
197	Houwtje Pauline De Kol	66747	Mar. 20	2—0—14	13	339.9	9.453	2.81	2.35- 3.5	1.173-1.527	102.0	101.3-2.9
198	Sadie Tietje Vale	68733	Mar. 20	2—11—3	6	256.0	9.079	3.54	3.0 - 4.4	1.165-1.389	101.9	101.2-2.8
	Average for 66 tests (62 different cows)	....	....	....	**44**	**290.4**	**9.994**	**3.45**	1.65- 8.0	.678-2.289	**102.1**	100.7-4.6
	Class V— Cows below two years of age.											
199	Dora Ormsby	58464	Apr. 18	1—11—27	8	287.7	9.731	3.48	1.9 - 5.4	1.321-1.529	102.0	101.3-3.2
200	Lottie Douglas 2d's Pride 2d	59196	Dec. 27	1—11—7	17	260.2	10.188	3.92	3.5 - 4.4	1.372-1.562	102.5	102.2-2.8
201	Johanna Clyde	60989	Dec. 26	1—11—14	29	282.6	10.690	3.78	2.8 - 4.6	1.444-1.739	....	....
202	Johanna De Pauline 4th	60992	Dec. 27	1—11—2	18	323.3	10.297	3.18	2.6 - 3.8	1.439-1.535	....	....
203	Piebe Estata 5th	61561	Jan. 27	1—10—18	20	198.1	7.140	3.60	2.6 - 4.2	.849-1.125	....	....

[1] Production during 13 days, April 19-May 1, '04: 691.0 lbs. milk, 18.995 lbs. fat; av. per ct., 2.75.
[2] Awarded eighteenth prize.

204	Aaltje Salo 5th's Netherland 3d......	61563	Nov. 5	1—11— 4	15	262.4	9.581	3.65	2.55- 5.4	1.264-1.469	102.4	101.9-2.9
205	Alice De Kol Wayne of Lakeside.....	61625	Mar. 22	1—11— 6	29	391.7	12.538	3.20	2.45- 4.4	1.677-2.071	102.3	101.8-2.8
206	Mercedes De Kol of Lakeside	61626	Mar. 17	1—11—22	7	283.2	10.720	3.79	3.1 - 4.7	1.354-1.723	102.2	101.8-2.6
207	Daisy M. P. Johanna.................	62227	Jan. 1	1—11—27	12	282.0	8.390	2.97	2.0 - 4.0	1.137-1.255	102.7	102.6-2.7
208	Skylark De Kol	62230	Nov. 24	1—11—20	11	276.4	10.223	3.70	3.2 - 4.4	1.353-1.521	103.1	102.0-4.2
209	Skylark De Kol Johanna	62231	Nov. 12	1—10— 5	53	232.6	7.675	3.30	2.9 - 3.6	1.074-1.117	102.9	102.4-3.4
210	Madge De Kol Johanna	62235	Nov. 24	1—11—29	10	310.9	10.084	3.24	2.7 - 3.75	1.392-1.471	102.7	102.2-3.2
211	Walworth Queen...	62436	Dec. 1	1— 6— 4	30	215.0	7.713	3.58	3.3 - 3.8	1.034-1.153	....	... ...
212	Olive De Cola 4th	63563	Jan. 26	1— 3—18	10	212.6	8.075	3.80	2.65- 5.0	1.102-1.255	102.3	102.3-2.3
213	Mercedes Siam De Kol...............	63612	Dec. 27	1— 9—29	13	253.6	7.847	3.09	2.6 - 3.75	1.034-1.223	103.1	103.0-3.2
214	Canary Mercedes De Kol	64454	Mar. 20	1— 7—18	53	248.8	7.456	2.99	1.6 - 4.15	.883-1.254	101.9	101.8-1.9
215	Aaggie Sadie Vale Concordia.........	64596	May 10	1—10—26	28	225.8	7.625	2.46	2.8 - 4.35	1.037-1.140	102.3	102.1-2.5
216	Sadie Vale Tirania.......	64598	May 8	1—11— 7	27	263.0	7.472	2.46	2.4 - 3.45	1.010-1.126	101.4	101.0-1.7
217	Una Lilly 2d De Kol	65295	Dec. 30	1— 8—23	9	202.9	7.364	3.63	2.6 - 4.25	.956-1.151	102.4	102.1-2.7
	Average for 19 tests (19 cows)....	....	....	....	**21**	**263.8**	**8.990**	**3.41**	1.6 - 5.7	.883-2.071	**102.4**	101.0-4.2

Thirty-day tests.—The data obtained on tests of Holstein cows continued for a longer time than seven days are given in the following table. The records given in the main body of the table are for thirty-day tests only and cover twenty-one tests with twenty-one different cows, all of the Holstein breed. The cows were owned by the following breeders.

1. M. S. Campbell, Genoa, Ill., Nos. 5 and 7.
2. W. S. Carpenter, Menominee, Mich., Nos. 11 and 13.
3. Wm. Everson & Sons, Lake Mills, Wis., Nos. 3 and 21.
4. F. B. Fargo, Lake Mills, Wis., No. 15.
5. S. B. Jones & Son, Watertown, Wis., Nos. 4 and 10.
6. A. N. McGeoch, Milwaukee, Wis., Nos. 6, 8, 9, 16 and 19.
7. Reddelien Bros., North Lake, Wis., Nos. 2 and 20.
8. C. A. Schroeder, West Bend, Wis., Nos. 1 and 14.

The following six supervisors had charge of these tests: James A. Ford tested cow No. 10; R. Elliot, Nos. 3, 4, 8, 9, 15–19 and 21; O. J. Hanzlik, Nos. 3, 6, 8, 9, 11, 13, 15, 19 and 21; Roy T. Harris, Nos. 2, 6, and 20; Bryant R. Ryall, Nos. 1, 2, 12, 14 and 20; Frank Stark, Nos. 5 and 7.

Thirty-day tests of Holstein cows, 1903-04.

Cow No.	Names of Cows.	Herd Book No.	Test began	Age.	Days in milk.	Yield in 30 Days. Milk.	Fat.	Per Cent. Fat. Average.	Range.	Fat per Day. Range.
	Class I—Cows five years old and over.			Y. M. D.		Lbs.	Lbs.			Lbs.
1	Netherland Bessie[1]	35997	Apr. 1	10— 9— 5	19	2185.4	83.897	3.84	3.4 - 4.7	2.710-2.923
2	Winnie Wartena Netherland	37630	Apr. 28	10— 7— 7	8	2331.0	88.709	3.80	2.85- 4.9	2.712-3.158
3	Canary's Mercedes Victoria	43780	Feb. 21	6— 2—22	11	1941.8	66.816	3.44	2.45- 5.05	1.681-2.579
4	Grace Fayne 2d[2]	44124	Apr. 7	7— 2—25	12	2524.0	85.859	3.40	2.8 - 4.2	2.600-3.184
5	Pietertje Echo De Kol	46977	Feb. 2	6— 1—14	53	1471.7	52.665	3.57	2.8 - 4.65	1.624-1.891
6	Duchess Orms y 2d's Queen[3]	48317	Mar. 27	5— 6—26	6	1672.7	71.715	4.29	2.55-10.5	2.105-3.926
	Average for 6 tests (6 different cows)	....	....	....	**18**	**2021.1**	**74.944**	**3.71**	2.45-10.5	1.681-3.926
	Class II—Cows four years old and under five.									
7	Mechthilde Daisy Checker[4]	52549	Feb. 2	4— 1— 3	24	1654.4	64.905	3.92	3.0 - 4.95	2.025-2.294
	Class III—Cows three years old and under four.									
8	Duchess Heugerveld De Kol	58178	Apr. 26	3— 1—16	11	1353.0	49.537	3.66	2.25- 8.2	1.419-2.217
9	Dora Ormsby	58464	Apr. 24	3— 0— 2	9	1456.3	46.924	3.22	2.1 - 5.4	1.366-1.725
	Average for 2 tests (2 different cows)	....	....	....	**10**	**1404.7**	**48.231**	**3.43**	2.1 - 8.2	1.366-2.217
	Class IV—Cows two years old and under three.									
10	Lady Oak 2d Piebe De Kol[5]	58644	Mar. 30	2—11—16	19	1539.4	59.569	3.87	3.0 -4.6	1.713-2.233
11	Lady Longfield 2d's Night	59192	June 10	2—10—15	17	1702.2	54.644	3.21	1.6 -4.75	1.529-1.971
12	Mazie Johanna	59194	Dec. 18	2— 1—11	16	1354.2	39.572	2.92	1.7 -5.25	1.170-1.676
13	Nina Duchess Melchior	59195	June 13	2— 8—29	37	1454.4	42.056	2.83	2.1 -4.0	1.272-1.461
14	Netherland Johanna De Kol 2d	61871	Mar. 26	2— 4— 3	20	1537.0	52.521	3.41	2.7 -5.0	1.527-2.207
15	Ava Colanthus Piebe[6]	61971	Mar. 13	2— 3— 1	8	1380.3	54.436	3.94	2.0 -6.05	1.371-2.181
16	Tritomia Ormsby	62359	June 4	2— 3— 5	7	1213.6	35.661	2.94	1.8 -5.6	.898-1.386
17	Rixa Ormsby	64349	May 30	2— 2—22	10	1118.6	37.954	3.39	2.0 -5.4	.888-1.597
18	Lady Ormsby	64352	May 30	2— 2— 1	10	1245.1	44.278	3.56	2.0 -5.9	1.192-1.892
19	Frankie Ormsby	64354	May 17	2— 2— 7	9	1256.1	39.868	3.17	1.9 -4.62	.955-1.519
20	Johanna Beechwood	65954	Apr. 29	2— 9— 8	231	1069.4	35.805	3.35	2.9 -3.71	1.071-1.348
	Average for 11 tests (11 different cows)	....	....	....	**35**	**1351.8**	**45.124**	**3.34**	1.6 -6.05	.888-2.233
	Class V—Cows under two years old.									
21	Alice De Kol Wayne of Lake Side[7]	61625	Mar. 3	1—11— 6	10	1594.1	49.028	3.08	2.3 -4.4	1.431-2.071

[1] Awarded second prize. [2] Awarded first prize. [3] Production during 60 days, Mar. 27-May 25, '04: 3,171.5 lbs. milk, 129.566 lbs. fat; av. per cent, 4.09; awarded ninth prize. [4] Awarded third prize. [5] Awarded second prize. [6] Awarded third prize. [7] Awarded sixth prize.

The number of prizes won by Holstein breeders whose cows were tested by representatives of our Experiment Station during the year ending May 15th, 1904, was twenty-seven for seven-day records and thirteen for thirty-day records. This was 30 per cent of the total number of prizes offered by the Association during the period given, and returned to Wisconsin breeders $923.00 in all in prize money. Among the prizes won in the seven-day tests were 2 first prizes; 1 second prize; 3 third prizes; 1 fourth prize; 3 fifth prizes; 1 sixth prize;3 seventh prizes; 2 ninth prizes; 3 tenth prizes, etc, and in the thirty-day contests, 3 first prizes; 2 second prizes; 3 third prizes, 2 fourth prizes, and one each of fifth, sixth and ninth prizes. But for the fact that owners were limited to three prizes, both in thirty-day and seven-day records, thirty-six Wisconsin cows would have received prizes for seven-day records and sixteen for thirty-day rcords. A few reproductions of prize-winning cows will be found throughout this article.

Only one retest was conducted by our Station during the past year, viz., of Ava Colanthus Piebe (No. 61971, see Fig. 25) owned by F. B. Fargo of Lake Mills, Wis. The retest was conducted by Messrs. Geo. A. Olson and R. Elliot for twenty-four hours, April 2–3, 1904. The results of the main test, March 21–28, in which the cow was credited with 338.9 lbs. milk and 14.188 lbs. butter fat, average per cent 4.19, were confirmed.

B. SEVEN-DAY TESTS OF COWS OF VARIOUS BREEDS.

A number of cows of the Jersey, Guernsey, Red Polled and Shorthorn breeds, with four grade Holstein cows, were tested by us for seven consecutive days during the past years, with the results given in the folowing table. The owners of the cows are given below.

1. J. Q. Emery & Son, Edgerton, Wis., Nos. 2 and 3.
2. August Seefeldt, Hochheim, Wis., No. 13.
3. University of Wisconsin, Madison, Wis., Nos. 1, 4–12, 15 and 16.
4. A. L. Williams, Fond du Lac, Wis., No. 14.

Cows Nos. 2, 3 and 13 were tested by R. Elliot; No. 14 by James A. Ford; Nos. 9, 12, 15 and 16 by Roy T. Harris, and Nos. 1, 7, 8, 10, and 11 by Bryant R. Ryall.

Seven-day tests of cows of various breeds, 1903-04.

Cow No.	Name of Cow.	Herd book No.	Test began	Age.	Days in milk.	Yield in Seven Days. Milk.	Yield in Seven Days. Fat.	Per Cent Fat. Ave	Per Cent Fat. Range.	Fat Per Day. Range.	Temperature of Cows. Ave.	Temperature of Cows. Range.
	Jersey cows.			Y. M. D.		Lbs.	Lbs.	Pr ct	Pr ct.	Lbs.	°F.	°F.
1	Lucy Miller	89115	Oct. 5	11— 6— 0	10	301.8	13.064	4.33	3.85- 4.9	1.831-1.917	....	....
1	Lucy Miller	89115	Feb. 3	11— 6— 0	131	168.4	9.830	5.84	5.2 - 6.9	1.092-1.451	....	....
2	Juanita of Emery Farm	156716	Jan. 14	4—10— 9	21	280.8	12.327	4.39	4.0 - 4.8	1.644-1.872	101.2	100.8-1.6
3	Pet Pedro 2d	161389	Jan. 14	3— 8—23	22	196.2	9.800	4.99	3.85- 6.8	1.260-1.565	101.2	100.4-2.0
4	Diploma's Brown Bessie	Not reg	Jan. 8	7........	25	247.3	14.122	5.71	4.1 - 7.1	1.767-2.270	101.1	100.8-1.5
	Av. for 5 tests (4 different cows)	....	....	....	**42**	**238.9**	**11.829**	**4.95**	3.85- 7.1	1.092-2.270	**101.2**	100.4-2.0
	Guernsey cows.											
5	Lady Jeweletta	15688	Jan. 8	5— 1— 9	21	282.7	14.197	5.02	3.9 - 6.2	1.818-2.181	101.1	100.8-1.3
6	Fair Cozie	15690	Jan. 8	3—10—21	23	199.9	10.598	5.30	4.35- 6.3	1.431-1.577	....	....
7	Muriel	Grade	Feb. 3	3........	308	75.5	5.214	6.91	6.2 - 7.7	.699- .773	....	....
	Av. for 3 tests (3 different cows)	....	....	....	**117**	**186.0**	**10.003**	**5.38**	3.9 - 7.7	.699-2.181	**101.1**	100.8-1.3
	Brown Swiss cows.											
8	Clara Barton	1567	Feb. 3	6— 4— 7	8	249.8	11.876	4.75	4.3 - 5.4	1.609-1.948	....	....
	Red Polled cows.											
9	Lady	Grade	Jan. 9	7........	13	406.1	17.566	4.33	3.55- 5.35	2.250-2.687	101.9	101.8-2.2
9	Lady	Grade	Aug. 4	7........	221	235.0	8.908	3.79	3.5 - 4.15	1.230-1.309	....	....
	Average for 2 tests (1 cow)	....	....	....	**117**	**320.6**	**13.237**	**4.13**	3.5 - 5.35	1.230-2.687	**101.9**	101.8-2.2
	Short Horn cows.											
10	Madison Rose (June)	Vol. 51	Feb. 4	4— 2—28	28	209.9	7.932	3.78	3.0 - 4.2	1.081-1.204	....	....
11	Julia 13th of Oak Grove	Not reg	Feb. 3	6—11—5	110	235.8	8.811	3.74	3.4 - 4.0	1.179-1.339	....	....
12	2d Miss Campbell by Doubleday	Vol. 39	Aug. 6	10— 8—14	13	237.2	8.405	3.54	3.3 - 4.0	1.155-1.238	....	....
	Av. for 3 tests (3 different cows)	....	....	....	**50**	**227.6**	**8.383**	**3.68**	3.0 -4.2	1.081-1.339	....	....
	Grade Holsteins.											
13	Rose (Seefeldt)	....	Oct. 20	9— 6.....	233	255.2	9.187	3.60	2.55- 4.5	1.098-1.561	102.2	102.0-2.4
14	Rose (Williams)	...	Dec. 15	5— 0—15	61	371.7	12.647	3.43	2.8 - 4.3	1.719-1.900	101.7	101.6-1.9
15	Donation	....	Jan. 9	7.	11	392.1	14.144	3.61	3.1 - 4.95	1.927-2.086	....	....
16	McGeoch	....	Aug. 4	6........	10	313.8	12.367	3.94	3.7 - 4.2	1.583-1.898	....	....
	Av. for 4 tests (4 different cows)	....	... ...	....	**79**	**333.2**	**12.086**	**3.63**	2.55- 4.95	1.098-2.086	**102.0**	101.6-2.4

C. TESTS OF GUERNSEY COWS.

Guernsey cows were tested once a month during the year in the herds of the following eleven Wisconsin breeders, viz.,

	No. cows tested.	No. one-day tests.
1. Ben Clark & Son, Whitewater	12	69
2. M. D. Cunningham, Kansasville	12	77
3. H. D. Griswold, West Salem	3	24
4. J. G. Hickcox, Milwaukee	4	22
5. Geo. C. Hill & Son, Rosendale	10	63
6. M. Nicholls, Trempealeau	3	4
7. O. T. Remington, Elk Mound	12	90
8. Fred Rietbrock, Athens	3	5
9. Fred Vogel, Jr., Milwaukee	8	28
10. University of Wisconsin, Madison	5	33
11. M. L. Welles, Rosendale	6	43
Total	78	458

The tests of cows owned by Messrs. Clark, Cunningham, Griswold, Hickcox, Hill, Remington, Vogel and Welles, continued throughout the year. Nicholls' cows were tested only twice, during the month of April, while tests in the University herd and in the herd of Fred Rietbrock have been continued since January and August of this year, respectively. The total number of individual monthly Guernsey tests made by our men during the year were 458. In the summary figures given on page 113 of this report, the number of cows tested have been included, and not the number of single monthly tests made by us.

The tests were conducted by the following supervisors: Messrs. Elliot, Ford, Harris, Hanzlik and Ryall. We were assisted in the conduct of the March tests of cows in Hill's and Welles' herds by Mr. Geo. A. Olson, and of the April test of cows in Clark's herd by Mr. W. B. Richards.

The monthly tests of the Guernsey cows in our University herd were conducted under the direction of Prof. W. J. Fraser, of Ill. Experiment Station, who verified the results obtained in the same way as in case of the tests of Holstein cows in our herd.

The following statements concerning the Guernsey cows tested and accompanying tables giving the results of the tests include only cows for which complete data for nearly all the months of the year are at hand.

Partial list of Guernsey cows tested, 1903–04.

Name.	Dropped.	Last calf.	Service.
Owners: Ben Clark & Son, Whitewater, Wis.			
1. Coralou, 15807	Sept. 15,'99	Sept. 12,'04	Not served.
2. Echlin, 13336	July 16,'96	July 29,'04*	Feb. 18,'04.
3. Coralura, 15811	Sept. 14,'00	Sept. 1,'03	June 22,'04.
4. Lula Bishop, 13368	Sept. 22,'96	May 21,'04†	Not served.
Owner: M. D. Cunningham, Kansasville, Wis.			
5. Do Fess, 11218	July 23,'98	Apr. 7,'04	July 11,'04.
6. Gertrude Kelly, 13709	Mar. 29,'01	Aug. 14,'03	Oct 30,'03.
7. Fess Do, 9072	June 12,'96	Jan. 9,'04	Apr. 28,'04.
8. Lip Amy, 14688	Oct. 2,'01	Jan. 8,'04	Mar. 30,'04.
9. Do Seig's Amy, 14686	Nov. 1,'01	Jan. 9,'04	Apr. 28,'04.
Owner: H. D. Griswold, West Salem, Wis.			
10. Primrose of Salem, 12524	Jan. 4,'00	Nov. 10,'03	June 6,'04.
Owners: Geo. C. Hill & Son, Rosendale, Wis.			
11. Rexa's Avis, 15242	Oct. 20,'97	Oct. 25,'03	July 1,'04.
12. Kanova, 14237	Feb. 2,'00	Oct. 8,'03	Jan. 25,'04.
13. Belle Brandon 2d, 16741	Fall, 1898	Dec. 13,'03	Feb. 2,'04.
Owner: O. T. Remington, Elk Mound, Wis.			
14. Lily's Maid of Richm., 15721	Nov. 1,'01	Sept. 30,'03	Feb. 5,'04.
15. Lou of Richm., 15727	Feb. 22,'02	Oct. 26,'03	July 1,'04.
16. Edine of Richm , 15722	Dec. 2,'01	Nov. 3,'03	Mar. 13,'04.
17. Laurel of Richm., 15724	Jan. 1,'02	Jan. 13,'04	June 18,'04.
18. Margis of Richm., 15723	Dec. 13,'01	Nov. 6,'03	Mar. 13,'04.
19. Helas of Richm., 15725	Feb. 6,'02	Jan. 6,'04	June 24,'04.
20. Frau of Richm., 15726	Feb. 12,'02	Dec. 30,'03	Jan. 20,'04.
Owner: Univ. of Wisconsin, Madison, Wis.			
21. Lady Jeweletta, 15688	Nov. 8,'98	Dec. 18,'03	Jan. 26,'04.
22. Glucose, 8496	Nov. 4,'95	Dec. 23,'03	July 21,'04.
23. Fair Cozie, 15690	Jan. 25,'00	Dec. 16,'03	Mar. 12,'04.
Owner: Fred Vogel, Jr., Milwaukee, Wis.			
24 Miss Mousie of H., 11505	Mar. 27,'98	Jan. 3,'04	May 30,'04.
25. Belle O. K., 12944	Feb. 13,'97	June 14,'04	....
Owner: M. L. Welles, Rosendale, Wis.			
26. Olive of Richm., 15815	Dec. 29,'00	Oct. 30,'03	Dec. 23,'03.
27. Minar C., 15809	Dec. 21,'99	Aug. 21,'04‡	....
28. Elsie Bishop, 15652	Dec. 28,'97	Nov. 20,'03	Feb. 7,'04.

* Aborted. Last calf Sept. 16, '03. † Aborted. Last calf Nov. 10, '03 ‡ Aborted.

Official tests of Guernsey cows, 1903–04.

Date.	Milk.	Fat.		Milk.	Fat.		Milk.	Fat.		Milk.	Fat.	
	Lbs.	Per cent.	Lbs.	Lbs.	Per cent	Lbs.	Lbs.	Per cent.	Lbs	Lbs.	Per cent.	Lbs.
	Coralou, 15807.			Echlin, 13336.			Coralura, 15811.			Lulu Bishop, 13368.		
Nov. 1903, ..	23.9	5.40	1.291	25.7	6.09	1.566	19.9	5.53	1.101	31.0	5.12	1.587
Dec.	23.6	5.84	1.379	28.0	5.22	1.461	21.6	5.49	1.185	36.9	4.74	1.750
Jan. 1904....	22.6	5.82	1.316	26.4	5.41	1.429	21.8	5.44	1.185	32.7	4.60	1.505
Feb..........	21.1	5.84	1.233	24.4	5.05	1.232	23.0	5.50	1.264	30.7	5.00	1.534
Mar	20.9	5.74	1.290	23.2	5.11	1.185	23.0	5.66	1.301	30.5	4.54	1.384
Apr..........	18.0	6.04	1.087	20.4	4.84	.988	22.2	4.90	1.089	25.7	4.94	1.269
May..........	20.2	6.44	1.301	22.6	5.16	1.166	24.2	5.17	1.252	27.9	6.01	1.676
June	18.2	5.63	1.024	19.8	5.40	1.069	19.7	4.95	.976	31.8	4.49	1.429
July	14.3	7.02	1.004	18.7	6.11	1.142	18.3	4.86	.889	26.3	5.11	1.344
Aug	1.7	7.70	.131	17.2	5.00	.860	19.5	5.14	1.003	24.3	5.39	1.309
Sept.........	32.8	5.65	1.853	10.3	5.94	.612	... ..	......	......	22.9	5.81	1.331

Date.	Milk.	Fat.		Milk.	Fat.		Milk.	Fat.		Milk	Fat.	
	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.	Lbs.	Per cent	Lbs.
	Do Fess, 11218.			Gertrude Kelly, 13709.			Fes Do, 9072.			Lip Amy, 14688.		
Nov., 1903...	13.4	6.72	.901	16.1	6.12	.985	20.5	4.45	.913	......	......	.....
Dec.	13.3	5.83	.775	16.5	5.38	.887	18.7	4.20	.785	......	......	.. ...
Jan., 1904....	12.8	5.70	.730	15.4	5.90	.909	16.9	4.20	.710	19.1	4.48	.855
Feb..........	11.6	5.40	.627	14.2	5.52	.784	15.7	4.25	.668	17.6	5.05	.888
Mar..........	......	......	......	14.8	5.47	.809	16.3	4.55	.741	16.5	4.91	.810
Apr..........	......	......	......	10.5	6.76	.710	13.0	4.62	.600	11.9	5.89	.701
May....	30.4	4.34	1.318	13.7	6.36	.872	17.6	4.50	.792	15.9	5.53	.880
June	29.2	4.00	1.168	12.5	6.14	.767	19.2	3.91	.750	17.1	4.83	.826
July..	24.3	4.30	1.046	7.4	6.40	.474	14.7	4.08	.600	15.3	5.04	.771
Aug..........	16.1	4.75	.764	......	......	......	11.0	5.40	.594	13.0	5.09	.662
Sept	......	......	......	......	......	......	5.7	4.60	.262	......	......	......

Date.	Milk.	Fat.		Milk.	Fat.		Milk.	Fat.		Milk.	Fat.	
	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.
	Do Seig's Amy, 14686.			Primrose of Salem, 12524,			Rexa's Avis, 15242			Kanova, 14237.		
Nov., 1903...	......	......	......	27.3	5.37	1.467	33.0	4.97	1.641	......	......	......
Dec..........	......	......	......	29.0	5.34	1.548	30.9	4.29	1.326	24.1	5.11	1.232
Jan., 1904...	20.5	4.58	.938	26.7	5.37	1.433	27.5	4.80	1.320	22.6	5.38	1.218
Feb..........	15.5	4.72	.731	27.7	5.54	1.535	25.0	4.81	1.203	19.2	5.36	1.030
Mar	15.4	4.73	.728	25.1	5.30	1.330	22.9	4.50	1.031	17.4	5.43	.945
April	11.4	5.82	.664	27.7	5.24	1.451	18.3	5.32	.973	15.2	5.72	.870
May..........	15.7	6.15	.966	27.8	6.27	1.743	22.0	4.35	.958	21.2	5.54	1.175
June.........	16.6	5.43	.901	25.8	5.88	1.516	23.9	4.33	1.027	20.9	5.41	1.127
July	12.2	6.31	.770	29.0	5.13	1.487	23.8	4.12	.981	16.9	4.53	.765
Aug..........	12.3	5.33	.656	22.4	5.49	1.229	.... .	......	......	11.9	6.17	.734
Sept.........	9.9	5.96	.590	17.5	6.16	1.153	.... .	......	......	9.8	6.79	.665

FIG. 31.—Coralou (No. 15807, A. G. C. C.), owned by Ben Clark & Son, Whitewater, Wis.

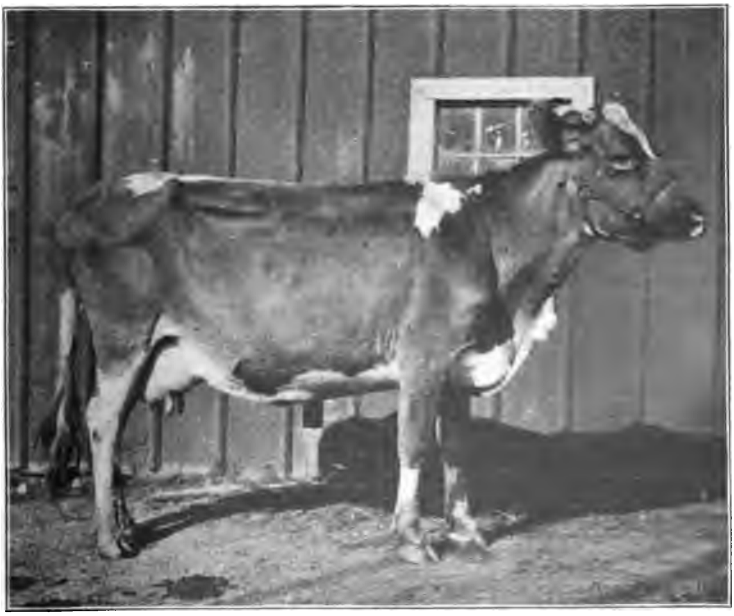


FIG. 32.—Sunbeam of Linden (No. 9683, A. G. C. C.), owned by J. G. Hickcox, Milwaukee, Wis.

Official tests of Guernsey cows, 1903-04—Continued.

Date.	Milk.	Fat.		Milk.	Fat.		Milk.	Fat.		Milk.	Fat.	
	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.
	Belle Brandon 2d, 16741.			Lily's Maid of Richmond, 15721			Lou of Richmond, 15727.			Edine of Richmond, 15722.		
Nov., 1903	......	......	....	26.7	4.25	1.134	21.0	5.55	1.166	22.7	5.15	1.169
Dec.	......	......	.....	26.4	4.77	1.260	19.9	5.95	1.184	22.0	5.45	1.200
Jan., 1904	31.7	4.52	1.436	22.6	4.95	1.119	17.6	5.95	1.047	19.2	6.50	1.248
Feb.	27.4	4.15	1.138	22.2	5.00	1.110	15.4	6.20	.954	19.3	6.66	1.286
Mar	26.7	4.25	1.135	20.7	5.20	1.076	15.0	5.93	.889	18.4	5.95	1.095
April	25.0	4.54	1.135	20.8	4.58	.952	15.5	6.03	.934	17.5	5.33	.932
May	32.5	5.28	1.717	22.7	4.78	1.084	17.8	5.65	1.006	18.6	5.31	.987
June	29.8	5.11	1.520	21.7	4.36	.948	17.1	5.79	.990	18.7	5.44	1.017
July	26.5	5.28	1.398	18.9	4.91	.930	16.3	6.24	1.001	17.3	5.29	.916
Aug.	17.5	4.93	.862	15.2	5.30	.805	13.1	6.28	.823	16.4	5.63	.923
Sept.	15.2	6.05	.919	17.5	5.24	.917	14.0	6.66	.923	15.5	5.33	.826

Date.	Milk.	Fat.		Milk.	Fat.		Milk.	Fat.		Milk.	Fat.	
	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.
	Laurel of Richmond, 15724.			Margis of Richmond, 15723.			Helas of Richmond, 15725.			Frau of Richmond, 15726.		
Nov., 1903	......	......	.....	25.9	5.60	1.451	......	......	......	......	......	......
Dec	......	.....	......	24.4	5.22	1.274	......	......	.....	......	......	......
Jan., 1904	29.0	4.75	1.378	20.3	5.30	1.076	25.5	4.68	1.193	26.9	3.96	1.064
Feb	23.0	4.80	1.104	19.5	5.85	1.140	24.2	4.35	1.052	24.4	4.77	1.165
Mar	23 5	5.13	1.205	18.7	5.95	1.113	20.2	3.99	.805	23.6	4.40	1.038
Apr	22.5	5.40	1.215	17.5	5.45	.954	21.2	4.25	.901	21 0	4.30	.904
May	22.6	5.15	1.164	18.3	5.52	1.011	19.7	4.09	.806	20.3	4 50	.913
June	23.5	5.19	1.219	20.0	5.37	1.074	22.1	4.14	.915	20.5	4.38	.898
July	22.3	4.94	1.101	19.7	5.25	1.035	19.1	4 76	.910	16 5	4.83	.796
Aug	16.3	5.71	.930	17.1	5.82	.995	17.9	4.53	.810	17.8	4.63	.824
Sept.	18.9	6.28	1.187	18.8	6.13	1.152	17.8	4.91	.874	16.8	4.81	.808

Date.	Milk.	Fat.		Milk.	Fat.		Milk.	Fat.		Milk.	Fat.	
	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.	Lbs.	Per cent.	Lbs.
	Lady Jeweletta,* 156 88.			Glucose, 8496.			Fair Cozie, 15690*			Miss Mousie of Homestead, 11505.		
Jan., 1904	282.7	5.02	14.197	16.7	6.41	1.071	199.9	5.30	10.598	25.6	5.77	1.476
Feb	29.1	4.35	1.266	17.6	5.06	.890	21.0	5.60	1.175	25.1	5.18	1.301
Mar	26.2	4.19	1.098	15.5	4.61	.715	20.8	5.44	1.131	21.7	5.06	1.098
April	19.5	4.60	.898	15.4	5.93	.914	17.9	5.83	1.044	22.7	5.55	1.259
May	23.3	4 90	1.142	12.6	5.52	.696	19.1	6.39	1.221	18.9	6.14	1.161
June	21.8	4.42	.964	13.6	5.45	.736	16.4	6.63	1.088	22.4	5.50	1.232
July	16.8	3.71	.624	10.6	5.39	.571	15.8	5.32	.841	21.4	5.57	1.191
Aug	9.7	3.94	.382	9 8	5.36	.525	12.7	6.20	.787	18.1	5.70	1.032
Sept.	......	......	......	7.5	5.98	.442	9.2	6.87	.632	28.9	4.85	1.403

* Seven-day tests during Jan., 1904.

FIG. 33.—Sukine (No. 10323, A. G. C. C., Adv. R. 47), owned by Geo. C. Hill & Son, Rosendale, Wis Production during 1903–4, 6881.5 lbs. milk, 354.07 lbs. fat; average per cent. fat, 5.14.

FIG. 34.—Select's O. K. (No. 12942, A. G. C. C., Adv. R. 117), owned by Fred Vogel, Jr., Milwaukee, Wis. Production during 1903–4, 8,916.1 lbs. milk, 418.58 lbs. fat; average per cent. fat, 4.70.

FIG. 35.—Miss Mousie of Homestead (No. 11505, A. G. C. C.), owned by Fred Vogel, Jr., Milwaukee, Wis.

Official tests of Guernsey cows, 1903-04—Continued.

Date.	Milk.	Fat.		Milk.	Fat.		Milk.	Fat.		Milk	Fat.	
	Lbs.	Per cent.	Lbs.	Lbs.	Per cent	Lbs.	Lbs.	Per cent	Lbs.	Lbs	Per cent.	Lbs.
	Belle O. K., 12944.			Olive of Richmond, 15815.			Minar C,. 15809.			Elsie Bishop, 15652.		
Nov., 1903...	23.2	5.36	1.243	22.7	5.20	1.180	22.4	5.75	1.287	......	......	... ..
Dec	19.2	5.08	.976	22.4	5.49	1.229	21.6	5.75	1.243	30.7	4.52	1.389
Jan., 1904...	15.2	5.68	.864	17.4	5.38	.937	18.9	5.64	1.067	28.3	5.00	1.415
Feb.	14.4	5.73	.825	15.3	5.47	.837	16.9	5.77	.975	26.5	4.68	1.241
Mar	9.0	6.00	.540	14.4	5.55	.799	15.6	5.35	.835	21.8	4.83	1.053
April.	......	......	......	14.8	5.89	.871	15.9	5.60	.890	20.7	4.66	.964
May........	....	......	.....	20.9	5.65	1.180	20.7	5.57	1.153	24.2	4.60	1.113
June	41.1	3.58	1.472	15.0	5.62	.843	22.1	4.92	1.087	27.8	5.20	1.446
July........	47.6	3.57	1.701	10.6	5.48	.581	20.9	4.98	1.040	23.1	4.61	1.065
August......	... ..	......	......	......	.... .	......	18.4	5.40	.994	8.3	5.04	.418
Sept.	......	......	......	......	.....	......	17.1	5.77	.986	3.0	6.03	.181

The following cows have been admitted to the Advanced Registry of the American Guernsey Cattle Club during the past year, on basis of the results of tests of milk made by our men and the milk production certified to by the respective breeders; the latter has to a certain extent been verified in each case by the results of the one-day tests which our men have conducted every month and by the weights for scattered days' milkings during the month furnished by them to the secretary, which serve as check weights on the owners' monthly reports.

List of Wisconsin Guernsey cows admitted to the Advanced Registry, A. G. C. C., 1903-1904, with production of milk and butter fat per year.

Name.	Herd-book No.	Advanced Registry No.	Pounds milk.	Pounds butter fat.	Average per cent fat.
Jolie's Sunbeam	8,800	107	9,254.0	470.97	5.10
Frau 2d	15,694	133	8,089.2	442.53	5.22
Belle R. 2d	12,940	108	8,551.4	442.25	5.17
Linnie	7,242	119	9,139.3	435.74	4.77
Coralura	15,811	176	8,137.4	427.24	5.26
Select's O. K.	12,942	117	8,916.1	418.58	4.70
Primrosedale	8,606	113	7,754.9	380.41	4.90
Do Fess	11,218	120	7,495.3	380.40	5.08
Frau	7,226	112	8,328.0	373.99	4.49
Fes Lip	10,621	76	7,979.0	373.92	4.69
Belle O. K.	12,944	156	8,086.8	365.79	4.53
Fesca	7,619	83	7,553.6	361.47	4.78
Graph's Princess	13,037	68	6,332.8	356.64	5.63
Do Zieg	11,219	75	6,464.1	337.53	5.22
Clio of Richmond	15,816	111	6,554.2	321.17	4.90
Frau 3rd	15,817	110	6,702.3	303.57	4.52
Primrosedale 2d	14,360	115	6,550.1	286.90	4.38
May Yeksa	13,446	114	5,884.9	285.39	4.85
Countess of Rosendale	13,493	161	4,876.9	273.96	5.61

D. TESTS OF JERSEY COWS.

The monthly tests of Jersey cows in the herd of F. H. Scribner of Rosendale, Wis., which were commenced in 1902, were continued until January this year. During the period covered by this report only four cows were tested in this herd, ten individual one-day tests being made in all. As the owner made tests of composite samples once every month during this time, additional testimony was obtained as to the comparative value of these two methods of ascertaining the annual production of butter fat by dairy cows.* The production of milk and of

*See Bulletin No. 107, page 11.

butter fat by these cows for the year 1903–04, on basis of the results of the tests made by the owner and by our men, is shown in the following table; the figures for milk yield reported by the owner are used for the calculation for the production of butter fat in both cases:

Comparative tests of Jersey cows.

NAME OF COWS.	Milk yield.	Av. PER CENT FAT.		FAT PRODUCTION.		Difference.	In per cent.
		Owner.	Station	Owner.	Station.		
	Lbs.			Lbs.	Lbs	Lbs.	
Heth Pogis, No. 103241 ...	8,071.7	5.92	5.90	478.1	475.5	+ 2.6	.5
Mabel's Surprise, No. 126876 ...	8,149.6	5.55	5.56	452.6	453.1	— .5	.1
Ernan, No. 152846 ...	5,584.1	5.27	5.25	294.4	293.1	+ 1.3	.4
Ripon Rosa, No. 111273 ...	7,966.6	5.17	5.12	411.8	408.1	+ 3.7	.9
Averages ...	**7443.0**	**5.50**	**5.47**	**409.2**	**407.5**	**+1.7**	**.4**
Av. 10 Jersey cows* ...	8,087.3	5.38	5.32	434.9	430.5	+ 4.4	1.0
Av. 7 Guernsey cows* ...	6,793.7	4.96	5.05	337.1	343.9	— 6.8	2.0

* Bull. 107, Wis. Exp. Sta., p. 11.

The results of the tests made by the owner and by our Station in this herd last year confirm the conclusion deduced from data previously published on this point, that the method of testing cows adopted by the American Guernsey Cattle Club by which the owner's figures for milk production for the month is multiplied by the average per cent of fat in a single day's milk during the month, will furnish substantially correct data as to the annual production of butter fat by dairy cows.

The rules governing the official tests of dairy cows, which have been in force during the past year, are given on pages 41–43 of our bulletin No. 107, to which readers interested in this subject are referred. Copies of this bulletin are still available and will be sent upon request, so long as the supply on hand lasts.

THE EFFECT OF DIFFERENT STABLE TEMPERATURES UPON THE MILK YIELD OF DAIRY COWS.*

W. B. RICHARDS AND E. L. JORDAN.

The object of this work was to determine what temperature should be maintained in a dairy barn to get the best results from the cows. In the course of this investigation many points of interest connected with the ventilation system and the ventilating of the barn, were brought out. In order to get a proper understanding of this work, it is necessary to know something of the ventilation system of the University Dairy Barn in which this work was carried on. A detailed description of this ventilation system can be found in the 15th Annual Report of this Station.

PLAN OF EXPERIMENT.

The plan followed to determine the best stable temperature for dairy cows, was to maintain the barn for a period of two weeks at a high temperature, and the two succeeding weeks at a low temperature. This method of procedure was necessary in order to make allowance for the advance in lactation of the trial cows. By this means, an average of the milk yield of the first and third two weeks could be compared with the yields of the second and intermediate periods.

The plan was to keep the temperature of the stable at about 45 deg. F. during the low temperature periods, and at about 55 deg. F. during the high temperature periods. It was difficult to uniformly maintain the stable at these temperatures, but due to the efficient ventilation system and the aid of a lim-

*Theses submitted for the degree of Bachelor of Science in Agriculture, University of Wisconsin, 1903 and 1904, respectively. Abstracted by W. B. Richards.

ited amount of heat, it was possible to keep it approximately at the temperature desired. The temperature of the Station barn can be regulated and modified by opening and closing certain registers in the system. Such regulation was often necessary as it was our desire to maintain uniform ventilation in the stable during both warm and cold periods.

At the time the writer carried on his work, twelve cows from the dairy herd were used, and when Mr. Jordan carried on his work, six cows were used. The cows were fed uniform rations during the trials and their appetites were watched during the high and low temperature periods of each trial.

The following table gives the milk yields and butter fat produced during each trial. A comparison is made of the results obtained when the stable was maintained at a high and low temperature.

TABLE I.—*A comparison of the production of the cows during the high and low temperature periods.*

Trial I.

	No. of cows in trial.	Milk, lbs.	Fat Per ct.	Butter fat.
Total yield during high temperature period (1 week)	12	1957.3	4.79	83.59
Total yield during low temperature period (1 week)	12	1878.5	4.42	78.15
Difference	....	78.8	.37	5.44
Trial II.				
Total yield during high temperature period (2 weeks)	12	4982.9	3.88	192.61
Total yield during low temperature period (2 weeks)	12	4865.9	3.90	189.81
Difference	....	117.0	—.02	2.80
Trial I—Jordan's work.				
Total yield during high temperature period (2 weeks)	6	1739.4	4.72	82.13
Total yield during low temperature period (2 weeks)	6	1735.9	4.82	83.81
Difference	....	3.5	—.10	—1.68
Trial II.				
Total yield during high temperature period (2 weeks)	6	2237.45	4.57	102.32
Total yield during low temperature period (2 weeks)	6	2326.3	4.43	103.1
Difference	....	—88.85	.14	—.78

From the results of the four trials made by both parties, three trials show a greater milk yield during the high temperature periods. In the first trial, the increase was 78.8 pounds, during the second 117.0 pounds, while the other trial shows only 3.5 pounds in favor of the high temperature period, and the amount of fat produced in this later trial shows an increase of 1.08 pounds in favor of the low temperature period. The remaining trial shows the milk yield to have been 88.85 pounds in favor of the low temperature period.

Two other trials were carried on by Jordan with cows that were crowded for records. The cows did not receive a uniform feed ration throughout the trials, so that the results are not comparable. The object of the trial was to determine what effect a warm stable would have on cows when they are crowded for a maximum milk production. The result of one trial is, that the cows gave 81.7 lbs. more milk when the stable was kept at a high temperature. During the next trial, they gave an excess of 12.3 lbs. during the cold period. An average of the results of all the trials, shows that the excess in the production of milk and butter fat was made when the stable was kept at a high temperature, or about 55 deg. F. Very little difference was noticeable in the amount of food consumed by the cows during the warm and cold periods.

THE TEMPERATURE OF THE STABLE.

During the progress of these trials, a continuous record of the temperature within the stable was kept by means of a self-registering thermometer or thermograph. This instrument was suspended in the center of the stable to record the mean temperature of the surrounding space. A record of the outside temperature for the corresponding time was obtained at the Washburn Observatory. A comparison of the indoor and outdoor temperature shows interesting results.

TABLE II.—*The daily temperatures of the stable and the outside during one of the periods.*

LOW TEMPERATURE.	INSIDE TEMPERATURE.				OUTSIDE TEMPERATURE.			
Date.	Max.	Min.	Ave.	Range.	Max.	Min.	Ave.	Range.
January 13	60	50	56	10	19	8	13	11
January 14	50	44	49	6	19	4	13	15
January 15	54	45	50	9	28	1	20	27
January 16	54	46	50	8	27	7	14	20
January 17	50	46	47	4	17	4	13	13
January 18	50	46	47	4	20	14	18	6
January 19	58	48	54	10	36	15	28	21
January 20	52	46	51	6	30	26	27	4
January 21	52	47	50	5	31	18	25	13
January 22	50	44	48	6	23	18	21	5
January 23	49	45	47	4	23	— 8	— 2	31
January 24	48	41	43	7	—2	—21	—18	19
January 25	49	40	44	9	—5	—26	—16	21
January 26	49	41	44	8	—4	—26	—11	16
Average	... .	....	48.6	7	....	....	10.4	16

The above table was inserted to show, chiefly, the daily variation in temperature, and the difference in range between the inside and outside temperature. On Dec. 23, the outdoor maximum temperature was 23 deg., and on Dec. 25th, the minimum temperature was 26 deg. F. For this range of 49 deg. in the outside temperature, the temperature in the barn only fell 9 deg. No artificial heat was used in the stable during this low temperature period. During such periods, the registers at the ceiling where the air passes out, are closed, and the ventilation of the barn is not seriously affected when it is so cold outside.

The following table gives the range of the indoor temperatures compared with the outdoor temperatures for each of the periods. In trial I of the writer's work, there was a range of 13.7 deg. in the outdoor temperature, and a range of 3.1 deg. in the stable temperature. Trial II of Jordan's work shows a range of 17 deg. in the outdoor temperature for the period, and only 6 deg. for the indoor temperature.

TABLE III.—*The inside and outside temperatures and the amount of air passing from the stable during each of the trials.*

Trial I.

	INSIDE TEMPERATURE.		OUTSIDE TEMPERATURE.		AIR PASSING OUT OF STABLE.	
	Ave.	Range.	Ave.	Range.	Cu. ft. per hour.	Av. cu. ft. per cow.
High temperature period.....	60.2	3.4	29	8.4	59789.05	1660.56
Low temperature period	44.4	3.1	10	13.7	74901.68	2080.60
High temperature period......	56	6.1	24	12.4	58916.56	1636.56
Trial II.						
Low temperature period.......	48.5	5.1	....	....	76545.28	2126.25
High temperature period......	57.5	4.9	....	....	82519.70	2292.21
Low temperature period..... .	46.5	5.3	....	....	93556.56	2598.79
Trial I.—Jordan's work.						
Low temperature period... ...	49	6.6	16	17	79286.34	2202.39
High temperature period......	56.4	8.	14.7	13	75389.94	2094.38
Low temperature period.......	48.6	7.	10.4	16	85447.13	2373.53
Trial II.						
High temperature period	55.5	6	6.4	18	88708.16	2464.11
Low temperature period.......	46.5	4.9	8.8	17	83947.63	2331.88
High temperature period......	59.	5.4	25.2	14.1	72932.16	2023.11

There are several reasons why the temperature of the stable can be kept so uniform. One of them is, that the stable is lined with galvanized iron sheeting, so that very little air enters the stable elsewhere than the ventilators. Another reason for this uniformity, is that on closing the registers which provide for the exit of the air near the ceiling, no air can escape except by way of the registers located near the floor. All air that passes out in this manner is the cold air that collects near the floor, consequently there is an economy of heat. With other conditions favorable, a stable that can be maintained at a uniform temperature such as these figures show, should aid materially in the production of maximum yields from dairy cows.

EFFICIENCY OF THE VENTILATION SYSTEM.

In order to determine the efficiency of the ventilation system, the amount of air passing out of the stable was measured by means of an anemometer. This instrument was placed in the main ventilating flue and a record was obtained of all the air that passed out of the stable each day. The figures show that much less passed out of the sable during the high temperature periods, because it was necessary to close some of the registers in order to keep the temperature high enough. This is especially true of the work done by the writer during the first trial as at this time no artificial heat was provided.

King shows, in his Physics of Agriculture, that a cow should be supplied with 3,642 cu. ft. of air per hour. The amount supplied the cows in the University Dairy Barn, according to the measurements made of the air passing out during these trials, falls short of the amount given by King. No allowance was made for what passed out by other avenues of escape. It is safe to assume that at least 10,000 cu. ft. per hour escaped in this way. Taking 80,000 cu. ft. per hour as an average of the amount measured we have 90,000 cu. ft. per hour as passing out of the stable. At this rate, the amount supplied the thirty-six head, approaches the theoretical figure very closely as the capacity of the barn is 32,200 cu. ft. At the above rate the barn would empty every twenty minutes.

This effort to determine practicable facts relative to the temperature, and the proper ventilation of a dairy barn, has been but an initiative step in the work. Much similar work will be necessary to determine definite conclusions on this subject. There are so many factors to be controlled and overcome in work of this kind that it is very difficult to carry it on successfully.

CAUSES OF VARIATION IN THE WEIGHT OF DAIRY COWS.*

F. H. KNOBEL.

In view of the popular claim that there is a variation from day to day in the weight of a given animal and little is known relative to the cause of such variation, the writer of this thesis, set himself to the task of determining:

1. Is there a variation in the weight of live stock?
2. What is the latitude of such variation?
3. In what direction from the normal is the greater variation?
4. What are the causes of such variation?
5. The degree to which each cause produces variation?

PLAN OF EXPERIMENT.

For the purposes of the experiment, six cows were selected from the dairy herd of the Experiment Station. All were in good health, accustomed to their environment, giving a good flow of milk, and living in identical conditions. Two of the cows were Red Polls, two Guernseys, and two Jerseys. Their ration, time of feeding, watering, and milking were kept uniform throughout the experiment. Weighings were, at the start, made to determine the variation, if any, in the live weight of the cows. They were likewise weighed before watering, once each week during a period of four moths—Nov. 2, 1903–Feb. 29, 1904.

*Thesis submitted for the degree of Bachelor of Science in Agriculture, University of Wisconsin, 1904. Synopsis by A. S. Alexander.

Variation in Weight. During the period, the cows gradually increased in weight, but not uniformly. Irregular variation was shown by the minimum and maximum weights of each cow, the extremes differing as much as one hundred pounds and the average difference between the weights being 97⅓ pounds. During the entire period, the general tendency of greater variation in the weight of a cow from her normal weight, proved to be toward the minimum rather than the maximum weight.

Gradual increase in weight explained a large part of the variation. Nov. 30, 1903, the herd weighed 5,558 pounds, an average of 926 pounds per head. Feb. 29, 1904, three months later, the aggregate weight was 5,960 pounds, an average of 993 pounds per head. This shows an average increase in weight of 67 pounds per head. The average difference between the extreme weights was 97⅓ pounds. Provided the cow was fed a maintenance ration only, so that her normal weight would not change, the average difference between the minimum and maximum weights for the herd, would then be the difference between 67 pounds and 97⅓ pounds, or only 30⅓ pounds. As, however, this 30⅓ pounds represents the difference between the extremes, the true variation in weight would only be about one half the difference between the extremes, or 15⅙ pounds.

The latitude of variation shown by daily weighings, proved to be much the same as that indicated by weekly weights.

Causes of Weight Variation. To determine the causes of variation in weight, it was necessary to know the exact weight of all feed and water entering into the weight of each cow, and the weight of her excretions in the form of milk, dung and urine. An attempt was also made to approximate the considerable weight gained or lost in the form of gas and vapor from lungs and skin, and in material used for maintenance of the body and repair of waste tissue.

Influence of Food. Each cow was fed the amount she would readily consume, and the ration was uniform throughout the experiment, so that little of the variation in weight from day to day should be attributed to any variation in quantity of food consumed.

Effect of Milk Production. The daily milk record of the cows showed little variation from day to day. The average of the maximum variations was 3.4 pounds, and it was concluded that the weight of each cow might vary from normal weight to the extent of 1.7 pounds on account of difference in milk flow.

Water Consumption. To determine the weight of water consumed by each cow, two methods were adopted and compared, viz., (1) Cows were allowed to drink from a pail and the difference of weight of water before and after drinking recorded, (2) The cows were weighed before and after drinking and the difference in weight taken as the weight of water used.

In no single case did the weight of water obtained by one method agree with that obtained by the other. In most cases the difference was not over one pound. The plan of weighing the water is the more accurate of the two. It was shown that the amount of water consumed by each cow varied more than any other factor considered. At times, the cow would drink nothing, then again as high as seventy-six pounds. The average amount drank at each time during seven days, was 20.8 pounds and for fourteen days, 22.4 pounds. The average difference between minimum and maximum of the seven day period was 48.5 pounds. The difference between minimum and maximum weight of water drank each day was not as great as that between single drinkings. The average amount drank during each day by the six cows for a period of seven days, was 39.4 pounds. This shows a field of variation in each direction from normal, or average amount drank, of 19.7 pounds. It is concluded, therefore, that the live weight of a cow may vary in either direction from the normal as much as 19.7 pounds, because of the varying quantities of water drank each day.

Weight of Solid and Liquid Excreta. The amount of solid excrement was carefully determined by weighing, for periods of twenty-four hours each. Variations were less than might be expected. In some cases, the weight was found to be surprisingly regular; others showed a wider variation. The average daily amount excreted per cow during seven days was

47.9 pounds. The average difference between the extremes for the six cows was 12.75 pounds. The variation on each side of the normal, or average amount excreted each day, was 6.375 pounds, so that it is concluded that the live weight of a cow may vary either way from normal to that extent.

The amount of water excreted through the kidneys was determined by catching the urine in pails, as voided, during several periods of twenty-four hours each. The amount was found to vary from day to day, and was small compared with the amount of water drank. The variation ranged within the limit of four pounds between the extremes, and it was concluded that the weight of the body may vary from the normal from day to day, to the extent of as much as two pounds, because of the irregular discharge of urine.

Under normal conditions, the combined excrements resulting from the alimentary tract and kidneys, weighed about the same from day to day; though changed conditions may result in a costive or relaxed condition of the bowel, in which case the weight of the body would change because of the material retained or excreted.

Heat Formation and Repair. Indirect deduction, from the tables showing figures from all the data included in this experiment, shows that twenty-three pounds represents the necessary amount, on the average, of food and water to be taken daily from the contents of the digestive tract in order to maintain the cow at her normal weight under normal conditions. There is, however, a variation in both directions from normal to the extent of ten pounds. This, too, is then a source of variation in the weight of a cow from day to day, in that it removes the weight of the contents of the digestive tract and transforms into heat, gas and vapor an amount that varies from day to day. The extent of this variation depends upon the conditions of the weather, state of health, excitement and general environment. In attempting to decide the amount of material transformed for the uses alluded to in the foregoing, it was assumed that the weight of the material consumed minus the weight of the excrements, including milk, and the gain or loss in the weight of the cow should equal the weight of the material thus used up in heat, and repair and that thrown off through the lungs and skin.

SUMMARY.

The causes of variation in weight, and the degree to which each is responsible, may be set down as follows:

Possible variation in weight due to milk is	1.7 lbs.
Possible variation in weight due to liquid excreta	2.0 lbs.
Possible variation in weight due to solid excreta	6.37 lbs.
Possible variation in weight due to heat repair	10.0 lbs.
Possible variation in weight due to water drank	22.4 lbs.
Possible variation in weight due to all is	42.47 lbs.

These figures are based on the average of the six cows tested, their average weight being 1,000 pounds. They represent a variation from the normal weight which may occur in either direction. Thus it may happen that the different variations may be such as to exactly offset each other and no changes result in the live weight of the cow; or it may happen that the variations are all in the same direction, resulting in a variation in the live weight equal to their sum, or 42.47 pounds in one direction, and perhaps the next day the same amount in the opposite direction, making a total difference in the weight of the cow, from one day to the next, of 84.94 pounds. These figures are based upon normal conditions. Abnormal conditions might result in even a greater variation. As a matter of fact, the normal variation is low. For instance, one cow in the test, whose weight was about 1,050 pounds, was weighed once each day for sixty days. Her variation in weight was noted from day to day during the entire period and found to average 16.5 pounds per day, without resulting in a change of her normal weight.

CONCLUSIONS.

The results of this investigation show, that the live weight of a dairy cow does vary; that the latitude of variation is within the limits of 30⅓ pounds; that in theory it may vary as much as 42.47 pounds; that in one case, by actual weights for sixty days, a single cow varied, on an average, 16.5 pounds per day; that the greatest variation from the normal is in the direction below the average weight; that there are five causes

for variation in weight from the normal, excluding the actual gain or loss of weight, viz., Variation in the amount of water drank; liquid excrement; solid excrements; milk flow; food transformed to heat, etc.

Lastly, the degree to which each is responsible under normal conditions is as follows:

Water drank	varies	22.4	lbs. or	52.75	per cent.
Heat and repair material	varies	10	lbs. or	23.52	per cent.
Solid excrement	varies	6.37	lbs. or	15.00	per cent.
Liquid excrement	varies	2	lbs. or	4.70	per cent.
Milk secretion	varies	1.7	lbs. or	4.03	per cent.
Total	varies	42.47	lbs. or	100.00	per cent.

RELATION OF FLAVOR DEVELOPMENT IN COLD-CURED CHEDDAR CHEESE TO BACTERIAL LIFE IN SAME.

H. L. RUSSELL AND E. G. HASTINGS.

The cause of the development of flavor in cheese has long been one of the disputed questions in dairy bacteriology. The ripening of cheese is a peculiarly complex phenomonon in which the development of flavor is a part, and much confusion on this subject has arisen from the fact that this phase of the question has not been differentiated from the breaking down of the casein. The importance of studies in the production of flavor is evident when one considers that the commercial value of the product is more dependent upon this factor than upon any other. The prevailing view has been, that in the formation of those peculiar by-products that give to ripened cheese its agreeable quality, bacterial organisms were most important. The evidence, however, as to the characteristic organisms concerned in the change, is far from satisfactory. The discovery that soluble enzymes (pepsin of the rennet extract and the inherent galactase in the milk itself) are largely operative in the digestive changes which the casein undergoes in the ripening process, has raised the suggestion that these factors might also have some influence, direct or indirect, in the production of the proper flavors, but it is difficult to prove any relation of this sort, for the bacterial activity in cheese cannot well be entirely inhibited without so changing the nature of the product that it is difficult to determine the character of the flavor.

It has previously been demonstrated that when fresh milk is treated with chloroform and made into cheese that the para-casein undergoes a digestive change that is quite comparable to that which occurs in a normal cheddar cheese but the presence of the chloroform so masks the flavor of the product that satisfactory data cannot readily be secured. In our experiments where cheese were prepared and left for some months under conditions which would permit of the evaporation of the anaesthetic, in part at least, it was possible to note the presence of more or less flavor and aroma although naturally this was masked by the presence of the chemical agent.

Von Freudenreich[1] has attached much importance to the presence of the lactic acid group as causal agents in the flavor production in Emmenthaler cheese. Experimental cheese made from milk drawn under aseptic conditions, and which therefore contained but few or no lactic acid bacteria developed no flavor, while cheese made from the same milk inoculated with lactic acid bacteria developed the typical Emmenthaler cheese flavor and aroma.

This view has been based largely upon the fact that these organisms develop so abundantly in the ripening cheese. In the studies of Harrison and Connell[2] on the bacterial content of cheese cured at different temperatures, they attach considerable importance to the fact that the cheese cured at lower temperatures has a higher germ content. They are inclined to consider that a causal relation exists between this high lactic acid germ content, and the improved flavor which is found in the cheese.

INTENSIFICATION OF FLAVOR IN COLD-CURED CHEESE.

In the previous studies on the cold-curing of cheese which have been conducted at this Station[3], attention has been drawn to the fact that the flavor of cold-cured cheese can be materially intensified, if the product is placed at a somewhat higher temperature (approximating 60° F) after the casein has been

[1] Landw. Jahrb. d. Schweiz, 1901, p. 158.
[2] Revue générale du Lait, 3; 80, 126, 150, 173.
[3] 19th Report, Wis. Agr'l Exp. Sta., 1902, p. 165.

more or less thoroughly broken down at the lower temperatures. If the cheese are kept at cold temperatures (40°–50°F) continually, they develop an exceedingly mild but delicate flavor which does not become strong even with age. In this respect the flavor differs greatly from that ordinarily found in an old cheese where the ripening has been carried on at the temperatures most frequently employed (65°–70° F. or above). If this thoroughly cured, but mild-flavored cheese, be placed at a higher temperature the flavor becomes intensified very rapidly, although the tendency to an undesirable sharpness is less than in cheese kept at the ordinary temperatures throughout the whole period. Taking this fact as a basis, it was thought that a bacteriological study of such cheese might throw some light on the question of flavor production. If the intensification of flavor was directly dependent upon the growth and development of the lactic acid group of organisms, then it is reasonable to suppose that the change in curing conditions from 40° or50° to that of 60° or thereabouts, would result in a renewed development of these characteristic organisms.

To test this hypothesis quantitative examinations were made of a number of cheese which had been ripened in cold storage for varying periods of time. They were then divided into two parts, one of which was restored to the original ripening room at 40° F. while the remaining part was placed at 60° F. Examinations, both physical and bacteriological, were made of the product at frequent intervals. These cheese were taken from a large commercial experiment on cold-curing, and therefore represented different makes of cheese from widely remote localities in the state.

The following history is given of the cheese, as to origin, etc. The cheese were made between September 26th., and October 4th., 1902. No. 173 was made by P. H. Kasper of Nicholson, Waupaca Co., No. 17 by Thos. Johnston, Boaz, Richland Co.; and No. 36 by H. J. Noyes, Muscoda, Grant Co.; and No. 416 at the University Creamery at Madison. All were close bodied, firm, typical, cheddar cheese. The temperature of the cold storage in which the cheese were kept until placed at 60°F. varied between 35° and 37°F. with an average of 36°F.

The cheese were only a few days old (3–5) when placed in cold-storage.

METHODS USED.

The plugs to be examined bacteriologically were taken with a sterile trier. Immediately after sampling the plugs were carried to the laboratory and cultures made. One gram of cheese removed from various parts of the interior of the plug was ground up in a small mortar with 20 grams of sterile sand. This was then placed in 200 cc of sterile water and plates made from this directly by using one cc of this suspension, or a further dilution was made into another flask of sterile water, and plates made from this. The medium used was lactose meat-gelatine. The culture-plates were incubated at room temperature, and were counted in 6–7 days by means of a hand lens, or in case they were so thickly seeded as to make this impossible, the low power of the microscope (×70) was employed. The latter method gave much lower results due probably to the inhibition of many organisms on account of the number of colonies developing.

While no especial attempt was made to differentiate the organisms present into the various groups, litmus lactose gelatine was occasionally used which showed that the major portion of the germ content was the usual acid-producing type that is so characteristic of cheddar cheese.

Cheese 173 was placed at 60° F. after having been in cold storage for 163 days. The cheese was divided for photographing. The half to be used for the experiment was coated with paraffine before being placed in the store room again.

Cheese 17 was placed in the 60° F. room after 178 days in cold storage. The cheese was not divided as in the case of No. 173 but another cheese of same age and make was used as a control. Cheese No. 36 was placed at 60° F. on the same date as No. 17.

The results of these tests are incorporated in the following tables, in which the bacterial content of the cheese is given for the different ages in comparison with the physical quality of the product.

TABLE I.—*Bacterial content of cheese partially ripened at 40° F.; then placed at 60° F. for varying periods of time.*

Cheese 173.			Cheese 17.		
Days at 60°.	Germ content per gram.	Physical condition.	Days at 60°.	Germ content per gram.	Physical condition.
0......	86,104,000	Well broken down, mild, clean flavor.	6	15,470,000	
4	89,984,000	....	12.....	12,073,000	
9......	71,440,000	Not to be differentiated from control.	24.....	3,776,000	Flavor slightly off, control shows clean flavor.
			47.....	7,280,000	
21......	96,950,000	Flavor much higher than control.	63.....	920,000	
39.... .	18,062,000	....	71.....	514,000	
49... ..	4,170,000	Flavor much higher than control.	81.....	280,000	Flavor high sharp, control mild.

The control half of cheese No. 173 kept at 40° F. was examined bacteriologically at the 39 day period, when it had a germ content of 39,568,000. Fifty-three days later it was again examined giving 41,068,000 and 30,356,000 in two samples. At the end of 39 days the cheese at 60° F. was beginning to deteriorate, the flavor being slightly "off" and the texture a little salvy. At this time the control showed a clean flavor and perfect texture, as it also did nearly two months later.

In the case of the control cheese of No. 17 stored at 40° F. the germ content at the six day period was 19,378,000, at the end of eighty-one days 4,004,000, at which time the flavor was still mild and clean while with the duplicate cheese at 60°, the flavor was very high, and it had a sharp, biting taste.

In both of these cases a marked difference is to be noted in the bacterial content of the cheese when stored at 60° and 40° F. Each time the germ content of the cheese stored at the higher temperature underwent much more diminution than did the control sample in the colder room. While the 40° F. product remained of mild and delicate flavor, the flavor of the other cheese became more and more pronounced, passing through a a favorable stage and then gradually becoming so pronounced as to be more or less objectionable.

The experiment was repeated with cheese selected from an entirely different make and of somewhat different age. From a lot of very fine cheddars of one make, two were selected that were seemingly alike in quality so far as they could be judged by physical standards. One of these (No. 36) was cured at 40° F. for 178 days and then transferred to the higher temperature while the control was kept at the original curing temperature for the whole period. The quality of the control remained mild and clean in flavor throughout the whole experiment while that of the 60° product was much intensified but still good. In table II is given the bacterial findings in this case.

TABLE II.—*Bacterial content of cheese partially ripened at 40° F.; then kept at 60° F. for 81 days.*

CHEESE 36.

Days at 60° F.	Germ content. Per gram.	Physical condition.
12	2,914,000	
24	2,275,000	Flavor slightly off, texture salvy, control, flavor good.
41	540,000	
63	378,000	
81	581,000	Sharp taste, very high, control, mild.

An examination of the control cheese was not continued throughout the whole period but when the 60° cheese had been at that temperature for 12 days, the germ content of the 40° cheese was 15,840,000 bacteria per gram, or over five times as many as in the other cheese. At the age of 81 days the cold cured product had 3,048,000 organisms per gram or about the same proportional increase over the other

The foregoing cheese were all six months old or older when they were first subjected to analysis. It was thought desirable to repeat the experiment using a somewhat younger cheese in which the germ growth had not gone on so far, Consequently a cold-cured cheese (No. 416) made at the University Creamery was taken at the age of about four months (124 days). It was then divided, part being placed at 60°F. and the remainder kept at 40° F. The examinations made on this cheese are as follows.

TABLE III.—*Bacterial content of cheese partially ripened at 40° F.; then kept at 60° F. for 82 days.*

CHEESE 416.

Days at 60° F.	Germ content. Per gram.	Physical condition.
0	18,308,000	
9	11,228,000	
25	2,277,000	
82	630,000	Flavor very high; sharp, control portion mild, low.

The control sample at the end of 25 days had 7,369,000 bacteria per gram and at 82 days 2,564,000 organisms or three to four times the number found in the cheese cured at 60° F.

COURSE OF BACTERIAL DEVELOPMENT IN CHEESE.

Before considering these changes, a brief recapitulation of the normal course of development of the bacterial life of a cheese will be helpful. Our previous studies[1] have shown that there is a marked increase in the bacterial life of a cheddar cheese within a few days after it is made, that this development may reach a point where the number of organisms may be measured by hundreds of millions per gram, that the majority of these forms belong to the lactic acid class of bacteria.

In Harrison and Connell's more recent studies on the bacteria in cheese they are inclined to consider that the maximum number of organisms is to be found at the time the cheese is taken from the press. In their observed data several cases are recorded where there is an increased number of organisms at later dates, but they attempt to explain these results on the ground of unequal distribution of the bacteria in the cheese. Undoubtedly the germ life in the cheese is far from being uniformly disseminated, and the every fact that this is so, increases the presumption that this unequal arrangement is due to the formation of colonies in the substance of the cheese. Gorini,[2] and more recently, Troili-Peterssen[3] have been able to demon-

[1] 13 Rept. Wis. Agr'l Exp't Stat., 1896, p. 95.
[2] Rev. genéralé du Lait, 3, No. 13, p. 289.
[3] Cent. f. Bakt., II Abt. Bd. 11, p. 650.

strate microscopically such aggregations of organisms of one kind, thus confirming the conclusion that actual proliferation of bacterial life goes on in the ripening cheese. If this is so, it naturally follows that a quantitative analysis of the germ life would show an increase after the cheese is taken from the press.

In the course of some weeks (more rapidly the higher the curing temperature employed), the germ life of the cheese dies off with marked rapidity. This decrease in numbers is quite rapid at first, but later becomes much retarded so that even in cheese of considerable age there are always many organisms to be found. The rise and fall of the contained bacteria is in considerable measure dependent upon the curing temperature. The lower this is, the slower the metabolic activity; therefore, in cold-cured cheese the course of development is much retarded, thereby prolonging the numerical bacterial content. This accounts for the relatively high initial number of organisms found in the cheese here studied when they were examined at the age of four to seven months.

The data presented above show without exception, a more or less rapid decline from the time the cheese were taken from the cold storage at 40° and placed at the curing temperature of 60°, a decline that is invariably more rapid than in the control cheese retained at the original cold-curing temperature. In neither case is there any reason to believe that any actual development of germ life has occurred. It is simply a case as to rapidity of disappearance. This increase in temperature seems to facilitate the metabolic activity of the organisms present. The fact that no increase in numbers was noted in any case whatever, is evidence that the processes that are responsible for the decrease in organisms present, were more active at the higher than at the lower temperatures.

The development of increased flavor does not immediately manifest itself at the higher temperature, but within a couple of weeks or so it is quite apparent and continues to become more pronounced, until it passes into a more or less undesirable condition. The development of off flavors does not occur as rapidly in these cheese as in those which are ripened throughout at higher temperatures.

The fact that this marked development of flavor occurs simultaneously with a sharp diminution in germ content of the forms that predominate in the ripening cheese certainly does not seem to be in harmony with the hypothesis that the growth of these organisms is directly related to the production of flavor.

Whatever agents are concerned in this process seem to be affected by the temperature in a profound way. As to the exact nature of these agents no definite answer as yet seems possible. So far as inferences can be drawn from these studies, it would appear more probable to consider that the immediate factors concerned in flavor production are likely to belong to certain chemical compounds of an unstable character that are liable to undergo chemical transformations with an increase in temperature; and that the real substances capable of producing these desirable flavors are easily affected decomposition products. As to the nature of the exciting agents capable of inaugurating these complex chemical transformations, little or nothing definite is known. It is not improbable that they may be bacteria; neither is it impossible that soluble enzymes may also function in their capacity as fermentative agents, setting up the initial changes which ultimately result in the production of the proper and essential flavor-producing compounds.

DISAPPEARANCE OF BACTERIA ARTIFICIALLY INTRODUCED INTO COWS' UDDERS.

H. L. RUSSELL AND E. G. HASTNGS.

A prominent factor in the infection of milk is the germ life which finds its way into the same from the fore milk. Since the introduction of bacterial methods of analysis, it has been generally shown that the germ content of the first few streams that are drawn from each teat is much higher than that which is subsequently received. It was naturally thought that this marked increase was due to the growth of organisms that found their way into the udder from the outside. The researches of Moore and Ward[1] have confirmed the conclusion that bacteria are to be found in considerable numbers in the milk cistern and sinuses, although no evidence has yet been adduced that points to an actual proliferation of these germs in the secreting cellular tissue of the udder itself. It is not so certain that growth may not actually occur in the spaces and cavities. If such multiplication does take place, experimental proof should be easily forthcoming by injecting into the udder certain specific forms and noting whether they are able to grow or not.

Some observers have made this experiment with organisms of one sort or another, and their results indicate an early disappearance of the introduced germ.

Ward[2] experimented with *Bacillus prodigiosus,* the well-known chromogenic species. This organism was doubtless used because of the ease with which it can be recognized in cultures. He was able to find only a few colonies even after twenty-four hours, and none were observed on the sixth day.

[1] Bull. 158, Cornell Expt. Stat.
[2] Jour. Applied Microscopy, 1898, 1:205.

The objection could well be urged that this species was not adapted to the experiment, so that the results here obtained might not be applicable in general. For work of this sort, it would seem that the use of a distinctively dairy type of bacteria would be better, and for that purpose, none could be more suitable than the specific sour milk or lactic acid species. Very rapid growth of this form normally occurs in the early history of milk, but as Conn has shown, this species is seldom found in any considerable numbers when the milk is first drawn from the animal. This fact would raise the presumption that even this distinctively dairy species might not be capable of growth under these conditions.

Dinwiddie has made the experiment of injecting into the udder a lactic form capable of curdling milk in twelve hours at 37° C. (98.6° F.). The examinations were not continued with regularity, but he was unable to recover the lactic acid organism at all.

EXPERIMENTS ON INJECTING BACTERIA INTO UDDER.

In our own tests on this question, we have used a number of different organisms. Several trials have been made with the common lactic acid form, B. *acidi lactici* Esten, also with an acid-producing liquefying form isolated from cheddar cheese, with *B. prodigiosus,* and a yellow liquefying coccus which is frequently found in the fore milk when milk is drawn under aseptic conditions. The tests have been made at different times and on different animals. In a number of cases here reported, the detail of injection and culture plating was carried out under our direction by one of our graduate students, Mr. C. C. Hayden.

METHOD OF INTRODUCTION.

In order not to produce any more disturbance in the udder than was actually necessary, the organisms to be tested were introduced by irrigation. A sterilized milking tube was connected by means of a small rubber tube to a glass container, holding the organisms in suspension. Most of the cultures

were grown on agar, and the growth transferred to 100–200 c.c. of sterile distilled water, or normal salt solution. The fluid was introduced at a slow rate, the udder being manipulated so as to distribute the same as much as possible.

The results obtained in these tests are summarized in Table I.

TABLE I.—*Persistence of various bacteria in cow's udder after artificial injection.*

Kind of organism.	Amount injected.	Effect on udder.	Period of exposure in udder (hours).													
			3	6	14	18	26	30	38	42	50	54	68	78	92	116
B. acidi lactici ..	5 cc	Milk abnormal for week	+	..	+	.	+		—	..	—	..	..	..	..	...
B acidi lactici ..	1 cc	None	+	+	..	—	..	—	..	—	..			..	..	...
B. acidi lactici ..	8 cc	Rapid swelling but soon subsided	+	+	..	+	..	—	..	+	..		..	..	..	...
B acidi lactici .	5 cc. ..	No effect.	+	+	.	+	—	..	—		..	..	..		.	...
Slow liquefy. acid-forming bacillus (cheese)........	24 hr. agar cult	Slight swelling; milk normal....	+	+		+	..	+	..	—	..	—	.	..	..	...
Slow liquefy. acid-forming bacillus (cheese)	5 cc	Udder swollen: milk clotted.	+	+	..	+	..	+	..	—	:	—	..		.	...
Slow liquefy. acid-forming bacillus (cheese).....	5 cc	Gargety milk	+	+	.	+	..	+	..	—	.			..	..	.
Yellow liq. coccus (fore milk).	24 hr agar cult	Milk abnormal for 3 days	..	+	..	+	..	+	..	+	..	—	+	..	—	—
B. prodigiosus .,.	3 cc	Rapid swelling but soon subsided.	+	+	.	+	..	+	..	+	..	+	+	—	..	...
B. prodigiosus...	5 cc	Milk very abnormal for several weeks..	+	+	.	+		+	.	* +	..	* +	* +	* +	..	...

+ = positive finding of organism; — negative finding.

* B. prodigiosus was found in small numbers in the milk clots, but not in the serum. Milk acquired alkaline reaction and the injected organism was found to be present for twenty-two days.

In none of the foregoing instances was there any quantitative evidence of growth. In all cases the number of introduced organisms that were recovered in the cultures was less and less as the period of exposure in the udder increased. It appears from these tests that none of the four species tried are capable

of surviving under these conditions for more than a brief period of time. This result might be anticipated in the case of *B. prodigiosus,* but in the case of the other forms, which are more or less distinctively milk bacteria, it is noteworthy that they do not find conditions suitable for development. The fact that the yellow liquefying coccus is so frequently found in fore milk naturally would be interpreted as indicating that this form was acclimated to these conditons, but its persistence in the one trial made with this species was hardly greater than in the case of the other forms tried.

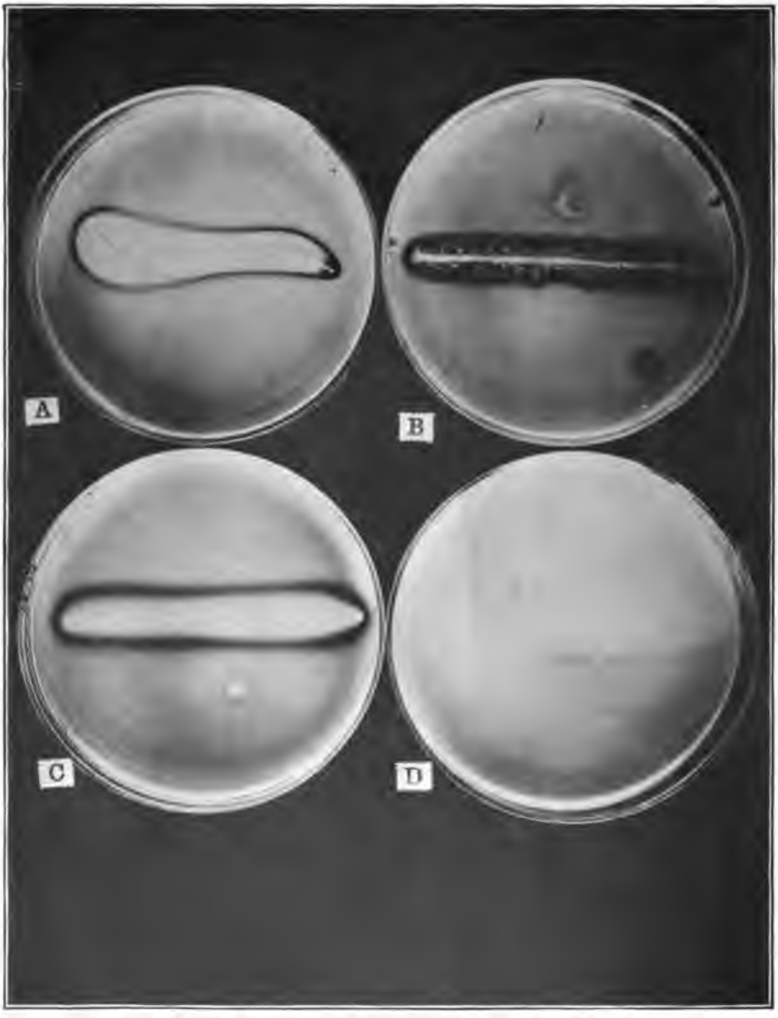
It is also evident from these tests, that the introduction of these supposedly harmless saprophytes causes a marked physiological disturbance in the tissues. In most cases, the milk became more or less abnormal, assuming a clotted condition. Not infrequently was the udder inflamed and tense, showing the production of a temporary garget.

What is the cause of this rapid disappearance of germ life? Is it due to the effect of germicidal agents present in the secretions of the cells, or is it merely because the introduced organisms are unable to accustom themselves to such a peculiar environment and therefore disappear from merely mechanical causes? The presence of germicidal substances in milk, has been a question that has been discussed for some years, but the evidence of such a property is not as complete as might be desired.

While it is true in a number of the above instances that the milk was more or less gargety and therefore abnormal, in those cases in which no gargety condition was produced, the respective organisms were unable to retain their vitality for a much longer period of time, showing that this variation did not seem to be of much moment.

Where the reaction was so abnormal as to be alkaline, *B. prodigiosus* persisted for several weeks. This might be taken to indicate that the death of the organism was not due to lack of adaptation to such an environment, at least so far as physical forces were concerned, for the species, although distinctively aerobic, was able to live for many days. It is at least a curious phenomonon that the action of these organ-

isms in the udder is so markedly different from that which is observed in the milk when it is drawn from the animal. These results would seem to indicate that the high germ content of the fore-milk was not attributable to the direct growth of forms in the udder itself, but more likely due, in large measure, to infection of the milk duct and possibly the external opening of the teat.



The action of acid-producing bacteria on casein as shown by milk-agar plates. A, action of commercial lactic acid; B, action of B. anthracis; C, action of B. acidi lactici in presence of sodium chloride; D, action of B. acidi lactici in absence of sodium chloride. The clear zones in "A" and "C" are formed by the dissolving of the mono-lactate of casein in the solution of sodium chloride. The opaque zones are produced by the dilactate of casein insoluble in sodium chloride solutions. In "D" both salts are precipitated on account of the absence of a dissolving agent. In "B" the clearing is due to the formation of water-soluble decomposition products under the action of the digesting enzyme.

A GRAPHIC METHOD OF DEMONSTRATING THE ACTION OF ACID-PRODUCING BACTERIA ON CASEIN

E. G. HASTINGS.

The action of bacteria, which produce proteolytic enzyms acting on casein, has long been known and with the majority of this class of organisms is easily demonstrated by the ordinary cultural methods. Not until the work of Van Slyke and Hart,[1] on the ripening of cheese appeared, was it known that other than liquefying organisms exerted any solvent effect on the casein of milk, either directly or indirectly. These investigators, working from a chemical standpoint, proved conclusively that compounds are formed between the casein or paracasein and the lactic acid produced from the milk sugar by bacteria. When small amounts of acid are produced, an unsaturated acid compound is formed, paracasein monolactate. With increasing amounts of acid, the saturated salt is formed, paracasein dilactate. The solubilities of the saturated and unsaturated salts vary, the unsaturated is insoluble in water, sparingly soluble in dilute solutions of calcium lactate and calcium carbonate, but soluble in 50% hot alcohol and in dilute solutions of sodium chloride. The saturated salt is insoluble in water, 50% hot alcohol and in solutions of sodium chloride.

The formation of the paracasein monolactate is to be considered as the first step in the ripening of cheddar cheese. The acid produced during the ripening of the milk in the cheese vat, combines with the casein. More acid is produced during the cheddaring process, so by the time the cheese is salted and put to

[1] Bull. 214, N. Y. Expt. Station.

press, the larger part of the paracasein has been converted into the monolactate. This compound is of such an acid nature that it is readily acted upon by the pepsin of the rennet extract, thus the nitrogenous matter is rendered soluble in water by the formation of albumoses and peptones.

Numerous investigations have established the fact that in the absence of lactic acid bacteria, a normal ripening of the firm types of cheese, cheddar and Swiss, does not occur because of the lack of acidity in the curd, a certain amount of acid being necessary for the action of the pepsin.

The accompanying plate shows, in a graphical manner, these reactions of acid and casein under the influence of lactic acid bacteria.

A medium is prepared by adding to ordinary nutrient agar 10% of sterile skim milk. To avoid the precipitation of the casein, the agar should be cooled to about 50°C. before adding the milk.

The plates are inoculated by making a single streak across the surface. The Petri dish marked "C," Plate I, shows such a culture after 72 hrs. incubation at 20°C. The growth of the organism is to be distinguished as a narrow line in the center of the plate. The transparent zone is due to the casein monolactate which is dissolved by virtue of the dilute saline solution of the medium. The more opaque zone, immediately adjacent to the line of growth, is due to the presence of the saturated acid salt of casein which is insoluble in the salt solution. The remaining opacity in the main body of the dish is that of the unchanged medium. It will be noetd that the opaque zone, adjacent to the line of growth, is more opaque than the unchanged portions of the plate. This is probably due to the finer form in which the casein dilactate is precipitated.

That the changes shown are really due to the acid, is demonstrated in dish "A." In this case, a thread moistened with lactic acid was laid upon the surface of the same medium as in "C." The same changes are to be noted as in "C," except that the more opaque zone is wider, as would be expected, on account of the larger amount of acid present.

In the absence of salts exerting a solvent effect on the mono-

acid salt of casein a different appearance would be expected. That this really occurs is demonstrated in "D," in which is shown the same organism as in "C," growing upon the same medium, except that no sodium chloride was added. In this case the zone occupied by the monoacid salt is not differentiated from that of the diacid salt on account of the lack of sodium chloride to dissolve the monoacid salt.

Plate "B" shows the changes produced in the medium by a liquefying organism *B. anthracis* after twenty-four hours incubation at 38° C. The peptones, formed from the casein by the action of the proteolytic enzyms elaborated by the organism, have dissolved, and to this is due the transparent zone. In the case of an organism forming but little acid, a change will be produced which might easily be mistaken for those caused by proteolytic enzyms. On account of the small amount of acid, no casein dilactate will be formed, only the monolactate which will be dissolved; the line of growth will be surrounded by a clear, transparent zone exactly similar to that formed under the action of proteolytic enzyms. The changes produced by the two types of bacteria, may easily be differentiated by flooding the plates with dilute acid. If the transparent zone is occupied by casein monolactate, casein dilactate will at once be precipitated and the opacity restored. If the solvent action is due to proteolytic enzyms, no change will be noted on treatment with acids.

This method furnishes a means of demonstrating, in a graphical manner, the reactions which have been shown by chemical methods to occur between casein and the acid produced by bacteria, and of showing the formation of two compounds. These compounds differing in their solubilities. The formation of the unsaturated salt of paracasein is held to be the first step in the ripening of cheddar cheese.

INFECTIOUSNESS OF MILK FROM TUBERCULAR COWS.

H. L. RUSSELL AND E. G. HASTINGS.

In the study of bovine tuberculosis, whether it is considered from the economic aspect of the stock raiser or in its hygienic relations to public health, no more important phase can be considered than the question as to the infectiousness of milk from affected animals. A recognition of the wider distribution of the disease than was formerly supposed to exist, which recognition has been mainly due to a more general application of the tuberculin test, has raised the fears of many persons that the danger to man from the ingestion of milk is very considerable. This has naturally led to a large amount of experimental effort and the literature on this subject is already quite voluminous. In spite of the numerous studies, however, the results are far from harmonious.

Concerning the danger from milk drawn from animals which show more or less positive signs of the disease generalized throughout the body, or localized in the udder itself, there is little or no dispute. Practically all are agreed that such cases are dangerous and that the milk from these animals does contain tubercle bacilli, although it has been thoroughly demonstrated that the shedding of tubercle bacilli does not occur in a continuous manner. On the other hand, the tuberculin test often registers a condition of infection within the animal which is so recent, and the lesions formed are so slight that there can hardly be any question as to the freedom of the milk from disease organisms. What point then, is one to consider, as the danger limit? Can the physical appearance of the animal be taken into consideration in determin-

ing whether the milk is infectious or not? Should the milk be condemned as unsuitable for food, for either man or beast, if it comes from a cow that shows a positive reaction to the tuberculin test, even though the animal herself may show no evident symptom of the malady? Manifestly a question of this character must be a difficult one to answer, and it therefore becomes necessary to increase the number of observations as much as possible so as to have a broad basis upon which to draw safe conclusions. Especially is this necessary with those animals that show no udder lesions or marked physical symptoms, for these make up by far the larger majority of cases found in affected herds.

In connection with the work of the Wisconsin Live Stock Sanitary Board it has been possible for us to accumulate some data on this point. In the prosecution of this work in the state, a considerable number of herds are tested for tuberculosis, and these tests are made with the view of eradicating existing cases of the disease as far as possible. It is not obligatory on the owner of reacting cattle to slaughter them. He may hold them in quarantine, if he wishes, under certain restrictions imposed by the Board, as to the use of the milk, etc., but in a considerable proportion of cases, the cattle that react to the tuberculin test are condemned and killed on the farm or at the larger packing centers where they are inspected by the federal authorities. Arrangements have been made with the State Veterinarian to secure samples of milk for bacteriological examination from such cattle as respond to the test, so that it would then be possible to correlate these tests with the actual postmortem findings. In this way it was hoped that additional data might be gathered which would have a direct bearing on the question at issue.

It is impossible, however, to draw any safe conclusions from our work at the present time, for the nature of this problem is such that a large amount of data should be accumulated before any definite decision is made. In the prosecution of this work, is was only hoped that such data as we might be

able to secure would add somewhat to the sum total of observations on this subject.

Some of the difficulties which pertain to the question at issue may be mentioned here as showing the necessity of a broad basis of observations.

1. It is well known that the tubercle bacilli are not thrown off from the affected body with any degree of uniformity. The appearance of the specific organisms in the sputum or in the milk is due to the breaking down of the tubercles in the invaded organ and naturally this process of softening does not result in any regular discharge. As a consequence, especially in the earlier phases of the disease, the milk might contain these organisms at one period and not at another. It would therefore, be much better to make serial observations on animals than trust to single examinations, but under the conditions imposed in this work, this was generally impossible. It should, therefore, be remembered that the value of a negative finding in this work is not nearly as great as it would be if a positive result had been obtained.

2. The method used in the detection of tubercle bacilli was to inoculate guinea pigs, with portions of centrifugalized milk. To produce the disease even in these experimental animals which are very susceptible, it requires a simultaneous introduction of a number of organisms. Wyssokowitsch found that at least 30 bacilli were necessary to produce the disease experimentally when injected into the peritoneal cavity. It therefore follows that milk might contain these organisms and yet the small quantity introduced would not harbor a sufficient number to give a positive result by this indirect method of determination. Mohler[1] showed that it was possible to find the organism microscopically and yet fail to secure positive results by animal inoculations, although generally the animal test is considered the more accurate measure of the presence of the organism. The animal test, however, may fail to yield positive results even when the presence of the organism is demonstrable. Such might be the case if the virulence or pathogenicity of the organism was unnaturally low. One

[1] Bull 44, B. A. I. U. S. Dept. Agriculture.

would not expect such results to obtain with an animal so susceptable as is the guinea pig, and yet, as a matter of fact, just such an occurrence was observed in the case of herd No. 1, shown in table I. As referred to in another article in this report (see page 178), the virulence of the tubercle organism isolated from one of the animals in herd No. 1 was so low that it required from one to four months to produce a lethal result in guinea pigs inoculated intraperitoneally with ordinary doses. This culture was doubtless so attenuated that even if it had been present in the milk, it would have been improbable that the disease would have been produced unless the sediment from an unusually large quantity of milk had been used. Of course, after all, in a study of the infectiousness of such milk, one would not really go astray if such a milk was regarded as negatively infectious, even though the specific organism might have been present.

3. The results of tests on the presence of tubercle bacilli in milk have been affected of late years by the discovery that there are other "acid-fast" bacilli not infrequently found in milk and milk products, which microscopically resemble closely the genuine tubercle bacillus, and which, strangely enough, are able to produce in guinea pigs a pathological condition that might easily be confounded with genuine tuberculosis. A correct differentiation can be made between these organisms and the true tubercle bacillus, but care must be taken in the interpretation of results or errors will be made.

For the above reasons it is evident that no satisfactory answer can be made to the original question at issue unless a large amount of data is secured and, that too, collected under widely divergent conditions. We have found it difficult to get many samples of milk for this test. The majority of the tuberculin tests made by the Live Stock Sanitary Board are made in the winter months at which time the larger proportion of animals in the herd are either dry or nearly so. It has, therefore, happened in a number of cases where a considerable number of animals were found to react that it has been impossible to secure milk samples for inoculation. In the following table, however, are given the results of a number of

such milk inoculations. In this inoculation work it has been customary for us to centrifugalize the sample and inject a varying amount of the mixture of sediment and cream.

TABLE I.—*Results of animal inoculations with milk taken from tuberculous cows showing no discoverable udder lesions.*

Herd No.	Serial No. of animal in herd.	Age of milk when injected (hours).	Amount injected (cc.)	Period of incubation in Guinea pig (days).	Treatment of expt. animal. K—Killed. D—Died.	Result: + Positive. — Negative.	Distribution of disease in animal from which milk was taken.
1 (W. C.) ..	23	24	4	55	K	—	Slight infection of peritoneal cavity.
"	15	24	3	126	K	—	Slight infection of posterior mediastinal g'ands.
2 (T. T.) .	22	24	4	103	K	—	Posterior mediastinal glands.
"	29	24	5	103	K	—	Lungs, posterior mediastinal glands.
"	9	24	4½	103	K	—	Retro-pharyngeal post. mediastinal glands, lungs.
"	10	24	5	1	D		Lungs, retro-pharyngeal glands.
"	20	24	4	103	K	—	Lungs, post. mediastinal glands.
"	21	24	5	95	K	—	Posterior mediastinal glands.
"	8	24	3½	103	K	—	Lungs. retro pharyngeal, post. mediastinal glands.
"	2	24	3	95	D	+	Lungs, retro-pharyngeal, post. mediastinal glands.
3 (C. McL)	1	48	3	54	D	—	
"	4	48	3	32	D	—	Lungs, bronchial glands, mediastinal.
"	5	48	3	165	K	—	
"	8	48	3	165	K	—	Lungs. post. mediastinal glands.
"	9	48	3	36	D	—	Lungs, post. mediastinal glands.
"	10	48	3	165	K	—	Retro-pharyngeal glands, portal glands, lungs, bronchial and post. med. glands.
4 (A. S.) ..	5	48	3½	154	K	—	
"	20	48	3½	43	D	—	
5 (F. B.) ..	2	72	3	1	D		Herd not slaughtered, but held in quarantine; no udder lesions discoverable.
"	3	72	3	3	D		
"	4	72	3	8	D		
"	5	72	3	134	K	—	
"	6	72	3	134	K	—	
"	7	72	3	3	D		
6 (J. F.) ..	....	72	1½	2	D		

In a number of cases, death of the inoculated pig occurred from septic infection in the course of a few days so that it was impossible to tell with certainty whether these samples contained the sought-for organism or not. Naturally those animals which were lost prior to the time required for the development of the tubercle bacilli, if they were present, should be eliminated from consideration before any conclusions could be drawn. It will be noted that this result occurred more frequently with herd 5 (F. B.) than any other. The age of the milk when injected (3 days) is evidently the reason for such a large number of cases of peritonitis.

In some cases also the cows from which the milk was drawn were not subjected to immediate slaughter (See herd 5) and hence it was impossible to make any direct comparison between the experimental findings in the inoculated animals and the actual stage of the disease in the original cows. As no evidence of infectiousness of the milk appeared in any of these cases, this lack of data is though, of minor import. Of the remaining cases only one showed a positive finding. It is evident from inspection of the last column of the above table that the disease in these cases was not particularly mild, but represented average conditions. Among investigators on this subject, widely varying results have been secured, and while the percentage in our cases (approximately 5%) is materially lower than in most of the reports which have been made, yet it does not differ so much from others. The data recorded are altogether too meager to permit of any conclusions and it is presented here merely to place on record some additional tests on the subject.

It should be remembered in a question of this kind that there is a potential as well as a present danger to be taken into consideration. Not only must one consider the actual percentage of animals now involved, but what may be of even greater import is the fact that these attainted animals which have reacted to the tuberculin test may, at any time, pass from a state of comparative innocuousness to one of positive danger, without betraying any outward visible sign of the trouble. It is, therefore, advisable to consider all milk from reacting cows as possibly dangerous and handle it accordingly. By the application of heat to a temperature of about 140° F. for a period of fifteen minutes or a briefer exposure at a higher temperature, the vitality of tubercle organism may be readily destroyed.

EFFECT OF SHORT PERIODS OF EXPOSURE TO HEAT ON TUBERCLE BACILLI IN MILK.

H. L. RUSSELL AND E. G. HASTINGS.

In the development of pasteurization as applied to preservation of milk and cream for direct consumption, the medical man and bacteriologist have, from the outset, insisted upon efficiency of treatment as a primary requisite. The cardinal principle which must be kept in mind is that no process of preservation can be regarded as satisfactory where the product is not treated in a way which will ensure the destruction of all but the spore-bearing bacteria and more especially all disease-producing forms. This is best accomplished by the use of heat, and therefore, it becomes necessary to know with accuracy the thermal death limits of the bacteria found in milk.

In the pasteurizing process, there are two ends to keep in view:

1. Enhancement in keeping quality which is secured through the destruction of the lactic acid or sour milk bacteria.

2. Death of disease-organisms (such as the tubercle germ) which may possibly be present in the supply.

In destroying bacteria in this way there are two factors which must always be considered, viz., time and temperature. The relation of each to the other is in general in an inverse ratio. The longer the exposure, the lower the temperature necessary to destroy. Of the two methods greater efficiency is to be attained where a lower degree of heat is used for a longer time than otherwise.

PASTEURIZATION STANDARDS.

As a result of this fundamental principle, the pasteurizing standards which have received scientific sanction have been those in which the milk has been exposed for a considerable period of time. The highest temperatures were used at which the milk and cream were not materially altered in taste and general appearance. The first standards selected were those formulated on the basis of de Man's[1] work, on the vitality of the tubercle organism in milk.

From these tests, a range in temperature from 150°–160° F. for 15–20 minutes was regarded as permissible. Under these conditions, however, the creaming property of the milk and the consistency of cream—factors of highest practical importance—are considerably diminished. The more recent work on the thermal death point of the tubercle bacillus showed that the limits set by de Man were needlessly high, and the experiments of Theobald Smith and ourselves have shown that it is possible to destroy this organism with certainty in 10–15 minutes at a temperature of 140° F. where the exposure is made under proper conditions.

The adoption of this lower standard has proven of material service in pasteurization, as at this temperature neither the creaming property of the milk is materially altered nor the consistency of cream impaired.[2]

Under these conditions of intermittent heating, it is possible to control thoroughly the pasteurizing process, and the results which have been obtained in our own practice in the University Creamery and numerous other pasteurizing plants, have demonstrated the success of the method under commercial conditions.[3]

DEMAND FOR MACHINERY PERMITTING MORE RAPID TREATMENT.

The only objection to this method of intermittent heating is that the capacity or output is necessarily limited, and there-

[1] Archiv f. Hyg., 1893, 18: 133.

[2] 16 Rept. Wis. Expt. Station. 1899, p. 129.

[3] See article entitled "The Milk Supply of a Hospital: American Method of Sterilization," by S. Phillips of St. Thomas' Hospital, London (The Hospital, July 16, 1904).

fore, numerous attempts have been made to introduce types of machinery that will permit of the treatment of a larger quantity in a given period of time. With the introduction into Denmark of the system of pasteurizing cream, and the subsequent ripening of the same with pure bacterial cultures, a large number of different kinds of apparatus have been devised. For the most part, these consist of machines which heat the whole milk or the cream as it flows through the apparatus in a more or less continuous stream. These so-called pasteurizers were primarily designed for the preparation of milk or cream for butter making purposes. For this purpose, there is not the necessity for as thorough a destruction of germ life, as is the case where the milk is treated for direct use, because a culture starter, which is rich in bacteria is immediately added to the heated cream.

On account of the increased capacity, many of these machines have been used to a greater or less extent for the preparation of milk for general city use.

From the milk dealer's standpoint, these machines possess undoubted advantages, as it is possible to diminish materially the cost of treatment in comparison with the other method. But if this increased output is secured at the expense of efficiency, it is questionable whether they should be recommended for general milk supply purposes or not. Nothing is to be gained by using the term "pasteurized" to apply merely to heated milk. The public have a right to expect that milk sold under this name has been treated in a way so as to *ensure* its freedom from deleterious and disease-breeding organisms.

So far as the destruction of bacteria in general is concerned, tests which have previously been made in apparatus of this class, indicate that efficient work cannot be expected where the milk is heated to less than about 175° F. Harding and Rogers[1] in their test of a Danish continuous pasteurizer (Hansen & Schroeder apparatus) obtained the following results.

[1] Harding & Rogers, Bull. No. 172, N. Y. Expt. Station.

TABLE I.—*Bacteriological results on milk pasteurized in a Danish continuous heater.*

Temperature employed, °F.	No. tests made.	BACTERIAL CONTENT OF MILK EXAMINED (PER C. C.)		
		Maximum.	Minimum.	Average.
158	14	62,790	120	15,290
176	25	297	20	115
185	7	234	50	113

The temperature which is now recommended in Denmark, is 176° F. Until very recently, the law required the milk to be heated to 185°, but at this temperature the product is somewhat changed.

Practical experience in commercial work has shown that when the milk is raised to 160° F., or thereabouts, the physical properties of the liquid are not sufficiently altered to be objectionable. The keeping quality of such milk is considerably better than the unheated milk, but it falls short of what is obtained where the milk is heated for the longer time at 140° F. The effect which is produced upon disease organisms, such as the tubercle bacillus, under these conditions has not been thoroughly studied. The carefully controlled experiments on this subject have generally been carried out under conditions where the time of exposure was much longer than in any of the continuous pasteurizing machines.

In view of the lack of definite knowledge on the influence of these very short exposures, we have undertaken experiments this last year where the thermal death point of this organism has been studied especially with the view of applying the results to the treatment of milk in the continuous flow type of pasteurizing machines. These studies are really a continuation of our previous work on the thermal death point for longer periods of exposure, and have been carried out in the same general manner.

METHODS USED.

Before taking up the results obtained, the methods of work will be detailed.

The medium used for the growing of all cultures was Dorset's egg medium. We have found this medium an excellent one for freshly isolated, as well as long cultivated strains, and the ease with which it can be prepared makes it suitable for general use. In making the suspensions, the growth was removed by means of a platinum loop to a sterile tube, and triturated in a 0.6% sterile salt solution until a homogenous suspension was obtained. This suspension was then added to whole milk which had been drawn directly from the cow into sterile flasks. The proportion of milk and suspension has varied in most of the experiments so that it is impossible to give accurate data as to the amount of culture introduced into each animal. In Series V, the amount of culture used was weighed accurately. This was then added to a definite amount of salt solution and milk; thus the amount of the growth proper given to each animal was easily determined.

The milk suspension was placed in small tubes, 7mm inside diameter, ¾mm wall, and of such length as to contain about 1½cc. The tubes, after filling, were sealed in the gas flame, the air space left was as small as possible. The heating was done in a large water bath, which had first been brought to the desired temperature, the tubes being placed on a shelf of wire cloth in close proximity to the thermometer bulb. At the end of the desired time, tubes were removed and chilled immediately in cold water.

Preliminary experiments had shown that it required about ¾ of a minute for the contents of the tube, as arranged, to reach the temperature of the water outside. Thus, in case of the shortest periods of exposure, the time at which the organism was exposed to the maximum temperature was very brief. Thus, in the case of the tubes exposed for one minute, the interval during which the organism was exposed to the maximum temperature could not have been over 20 to 25 seconds.

All animals were inoculated intraperitoneally.

HISTORY AND ORIGIN OF CULTURES EMPLOYED.

Culture 101. Human.—This culture was isolated by us from a case of tuberculosis in the last stages. The animal inoculated with sputum was killed, and cultures made on Dorset's egg medium. The organism, when used for the experiment, had been grown on artificial media three months; the third generation being used. Age of cultures when used, 33 days.

Culture 109. Bovine.—This culture was isolated by us from a cow that had reacted to the tuberculin test in 1903. A guinea pig was inoculated with a suspension of the broken down cheesy nodules from a lymph gland. The animal died in 44 days with generalized tuberculosis of the peritoneal and pleural cavities. From the spleen and liver of this animal, another was inoculated. This pig died in 34 days with generalized tuberculosis of the abdominal cavity. Cultures were then made on egg medium from liver and spleen.

The culture has always been low in virulence. Besides the data given above, the following illustrates this point: A guinea pig was inoculated intraperitoneally with 1 cc of a suspension of the density of a 24 hr.-old typhoid culture. The animal died in 20 days. Another inoculated with 1 cc of a suspension 50 times more dilute, died in 51 days.

The culture, when used in the experiment, had been grown on artificial media for about one year and had been transferred at intervals of about one month. The cultures used were 28 days old.

Culture 110. Bovine (designated as B_1 in Dr. Baldwin's laboratory).—This culture we received through the courtesy of Dr. E. L. Baldwin, of Saranac Lake, N. Y. It was isolated Nov. 8, 1902, from a guinea pig inoculated Oct. 15, with caseous lung tissue of a cow, discovered to be tuberculous by the tuberculin test. The culture was of high virulence, killing adult guinea pigs in 11 to 14 days when inoculated intraperitoneally with 5 mg. of culture. Ten mg. of about the eighth transfer on Loeffler's sheep serum, killed two young

cattle in three weeks, after intravenous inoculation. The cultures were 30 days old when used in our experiments.

DISCREPANCIES IN RESULTS OF DIFFERENT OBSERVERS.

Before taking up the results of this work in detail, mention should be made of the fact that in spite of the numerous observations that have been made on the thermal death point of the tubercle bacillus, marked discrepancies are to be noted in the work of different investigators.

The studies which have been made by Theobald Smith[1] and ourselves,[2] on the influence which the surface pellicle, or "scalded layer," exerts on the vitality of the organism doubtless will account for much of the variation observed. In the earlier work by different investigators, no account was taken of this important factor, but in all of our experiments, we have excluded its influence by making the exposure under conditions which would not permit of the formation of this protective pellicle. While the results obtained in these investigations have given a materially lower death point than those of the earlier observers, these conclusions have been confirmed by Hesse[3] and also by Macfadyean,[4] indicating that a revision of the earlier conclusions that have previously been accepted, must be made.

Again, there is evidence that the varying nature of the germ used, may exert a material influence. This point will be discussed on the basis of some data to be presented later in this article, but we have found that the virulence of the exposed organism is of importance where reliance is placed upon the animal method of testing whether this organism has been killed or not.

EXPERIMENTAL WORK ON EXPOSURES FOR SHORT DURATION.

It is exceedingly desirable in selecting a practical, commercial standard for pasteurization, that a limit be chosen at which the milk or cream suffers little or no material change in phys-

[1] Jour. Expt. Med., 1899, 4: 217.
[2] 18 Report Wis. Expt. Station, 1901, p. 185.
[3] Zeitschr. f. Thiermed. 5; 321.
[4] The Hospital, July 16, 1904.

ical properties (taste, creaming property, etc.); and inasmuch as general experience seems to indicate that a temperature of 160° F. can be used in these continuous-flow type of machines without serious impairment of these qualities, we have selected this as the standard temperature at which these short time exposures should be made.

SERIES I—(HUMAN CULTURE NO. 101) AT 160° F.

The first series of experiments was made with the human strain of the organism (culture 101), the exposures being made at 160° F. for a period ranging from 1–10 minutes. The results are presented in Table 1.

TABLE 1.—*Results of animal inoculations with milk heated to 160 degrees F.*

Time heated (min.).	Period of incubation in animal. (Days.)	Result.	Remarks.
0	27	+	(Died, disease generalized throughout body cavity.)
1	132	—	Killed.
1	111	—	Killed.
2	132	—	Killed.
3	132	—	Killed.
3	132	—	Killed.
4	132	—	Killed.
5	132	—	Killed.
5	132	—	Killed.
7	132	—	Killed.
7	132	—	Killed.
10	111	—	Killed.

+ Tuberculosis developed; — no disease demonstrable.

These tests indicated the destructive influence of the heat employed (160° F.) for the whole range of exposures used, as in no case was the disease transmitted to any of the experimental animals except those inoculated with the unheated milk. This culture was, however, of human rather than bovine origin, and its virulence was relatively low (27 days in control) when compared with the bovine strain of this bacillus.

SERIES II–IV—(BOVINE CULTURE NO. 109) AT 160°, 175° AND 185° F.

In these three series the influence of both time and temperature of exposure was studied, in that a range from 160° to 185° F. for one to ten minutes was employed. This time a culture of bovine origin was used and also one which had been quite recently isolated from the animal. In this way it was thought to make the experiment conform more closely with what would occur under natural conditions. The results obtained are shown in Tables 2–4.

TABLE 2.—*Results of animal inoculations with milk heated to 160 degrees F.*

Time heated (min.).	Period of incubation. (Days).	Result.	Remarks.
0	115	+	Killed. Pronounced case of generalized chronic tuberculosis.
0	39	+	Died of an abscess, although tubercular at death.
1	84	—	Killed.
1	115	—	Killed.
2	84	—	Killed.
2	115	—	Killed.
3	12	—	Died.
4	27	—	Died.
4	115	—	Killed.
5	115	—	Killed.
7	115	—	Killed.
10	115	—	Killed.

Before discussing these results, it may be well to present the data obtained in the series heated to 175° and 185° F.

TABLE 3.—*Results of animal inoculations with milk heated to 175 degrees F.*

Time heated (min.).	Period of incubation (Days).	Result.	Remarks.
0*	115	+	Died, tubercular.
0*	39	+	Killed, tubercular.
1	84	—	Killed.
1	115	—	Killed.
2	84	—	Killed.
2	115	—	Killed.
3	115	—	Killed.
4	115	—	Killed.
4	115	—	Killed.
5	115	—	Killed.
7	115	—	Killed.
10	73	—	Died.

* The two control pigs inoculated with unheated milk as shown in table II, served as controls for the experiments described in this and following table.

TABLE 4.—*Results of animal inoculations with milk heated to 185 degrees F.*

Time heated (min.).	Period of incubation (Days).	Result.	Remarks.
0	115	+	....
0	39	+	....
1	84	—	Killed.
1	115	—	Killed-
2	115	—	Killed.
3	115	—	Killed.
4	115	—	Killed.
5	115	—	Killed.

From these three series it appears that negative results were obtained throughout, that in no case was there any evidence that the heated organism was able to produce the disease when inoculated into guinea pigs. It might seem at first sight as if this conclusion was a wholly valid one, inasmuch as the results of all the series up to date were concordant. Care had

been taken in these three series to use a culture of bovine origin, and one which had been recently isolated from its animal host. However, one factor in these series was apparent and that was the low degree of virulence of the culture. It will be noted in the above series (Table 2) that the controls did not die from the result of the inoculation for quite a long period. One of these animals died in thirty-nine days from an abscess, which broke and discharged into the pleural cavity. Postmortem examination showed the presence of generalized tuberculosis of the abdominal cavity, which had, however, not reached a stage that was fatal. The spleen was much enlarged and filled with small nodules; the liver covered with necrotic aeras; mesenteric lymph glands enlarged. The surface of the peritoneum was covered with minute tubercles.

The remaining control animal remained alive for sixteen weeks, although showing a chronic type of the malady. It was chloroformed on the one hundredth and fifteenth day, and the following lesions observed. All the organs of the abdominal cavity were tubercular, the lymph glands much enlarged, the lungs showed consolidated areas, and numerous tubercles. The inguinal lymph glands were much enlarged, as was one of the axillary glands. On the whole, the disease represented a case of thoroughly generalized, chronic tuberculosis.

The difference noted in the period of incubation between the control animals may be explained by the fact that the second control had two large tumors, one on the throat and the other on the wall of the thorax, the discharge of which into the thoracic cavity caused the death of the animal.

Evidently this organism was one of exceedingly low virulence for a bovine strain. This conclusion is further borne out from data collected from the original herd of cattle affected with this particular organism. As noted before, this culture was isolated from a guinea pig, which had been injected with material from an affected lymph gland of a cow that had reacted to the tuberculin test. There were 52 animals in the herd of which this cow was a member, and of these 37 reacted to the tuberculin test. It was decided by the owner

that he would have them slaughtered under the auspices of the State Live Stock Sanitary Board, and killing of the same was begun, but it was found in the larger majority of cases that the lesions were comparatively insignificant. The wide spread distribution of the disease in the herd indicated that an infected condition had prevailed for a long period of time, and the nature of the lesions did not seem to indicate recent infection. These clinical facts appeared to show that the invading organism was of relatively mild virulence and specimens were saved to isolate the specific culture therefrom. The guinea pig which was originally inoculated with the tissue from the cow did not die until forty-four days after injection. A second pig was immediately inoculated with material from the spleen and liver of the first pig. This animal died in thirty-four days from generalized tuberculosis of the peritoneal cavity. From this pig pure cultures were isolated which, upon further retesting, showed a low state of virulence, the inoculated guinea pig living for about one month.

From the history it is apparent, that the virulence of this culture was much lower than is ordinarily found in organisms of a bovine origin. This particular phase of the question was not fully appreciated at the time this thermal death-point work was instituted. The culture was selected because of its bovine origin, and also because it happened to be the most recently isolated strain that we had at hand.

The results which were obtained in the foregoing experiments must be interpreted in the light of the fact that the virulence of the culture used was exceedingly low. It would be unsafe, in view of this, to consider that the vitality of the organism had been completely destroyed by the degree of temperature employed. It is quite conceivable that an application of heat might reduce the vigor of the organism to some extent and yet not wholly destroy its vitality. It might be sufficient, however, to prevent the organism from developing its usual pathogenic function.

SERIES V—(BOVINE CULTURE NO. 110) AT 160° F.

Under these circumstances, this question of virulence having been raised, another series of experiments was instituted. We are indebted to the kindness of Dr. E. L. Baldwin, of the Saranac Laboratory for the study of Tuberculosis, Saranac Lake, New York, for a culture of bovine origin of much higher degree of virulence. The history of this culture is detailed on page 183.

The inoculations were made as in the preceding series, the milk being heated to a temperature of 160° F., for periods varying from one to ten minutes. The results of this series are presented in the following table:

TABLE 5.—*Results of animal inoculations with milk heated to 160 degrees F.*

Time heated (min.).	Dosage mgrs. of wet culture.	Period of incubation. (Days).	Result.	Remarks.
0	6.0	10	+	Died. Tuberculosis generalized throughout peritoneal cavity and visceral organs.
0	2.5	11	+	Died. Perit. cavity and visceral organs affected with tuberculosis.
1	2.5	38	—	Killed. Nodules in meson. fold enveloping pancreas, some caseous. T. B. found in both caseous and non cas. nodules.
1	2.2	57	—	No evidence of tubercular lesions
2	3.2	38	—	Killed. Few nodules in mesent. fold, non caseous.
2	2.5	57	—	Nodules in pancreatic fold, some caseous.
3	6.1	12	—	Died of digestive trouble as shown by inflamed condition of intestines: Spleen and pancreas enlarged. T. B. demonstrated: fibrinous flakes on liver containing T. B.
4	5.0	57	—	Perfectly free from all nodular masses.
5	6.1	23	—	Died. One fibrinous flake on liver and nodules on pancreas containing T. B. Cause of death unknown.
7	5.6	57	—	Pancreatic fold contains some nodules.

In the above series it appears that the animals inoculated with the unheated milk died very quickly (10 and 11 days), thus indicating the highly virulent character of the culture used. With those animals inoculated with milk heated for varying periods of time, a much different post-mortem picture was noted.

In two cases (one minute and four minute pigs), absolutely no trace of any pathological lesion could be noted, although they had received 2.2 and 5.0 mgrs. respectively, of the moist growth removed from a solid culture. In the remaining cases including pigs inoculated with milk heated for 1, 2, 3, 5 and 7 minutes, lesions of the following character were found.

In the mesenteric fold enveloping the pancreas, small, nodular masses, 3–4 mm., in diameter, were noted in varying numbers. Sometimes only a few of these nodules were found; again from 10 to 12 or more were present. These nodular growths were firm, hard, and apparently composed of connective tissue. Usually they were solid throughout and only in one case or so had the interior of the nodule undergone caseous changes.

Generally speaking these abnormal lesions were confined to the tissue referred to but in one case, soft fibrinous flakes were found on the surface of the liver. Usually the spleen and pancreas were normal in size.

A microscopic examination of these nodular masses and the fibrinous flakes as well, revealed the presence of tubercle bacilli which took up the stain, but in some cases the cells appeared to have undergone degenerative changes. The bacilli were demonstrated in both the caseous pus from the interior of the tubercle and the firm, white, hardened nodules.

The gross anatomy of these nodular masses and their distribution in the tissues, as well as the microscopic appearance of the organisms themselves, seemed to indicate that these histological structures were not normal tubercles, such as are usually found in generalized tuberculosis. It seemed quite probable that such changes might be produced by dead tubercle bacilli as described by Prudden and Hodenpyl.[1] They found that the injection of dead tubercle organisms resulted in the formation of firm, fibrous nodules, which ordinarily did not undergo caseation. These nodules may be easily mistaken for genuine tubercles, unless their structure is closely studied. To prove whether these masses were really produced by living organisms or not, guinea pigs were inoculated with emulsions made from this material, in which tubercle bacilli had been microscopically

[1] N. Y. Med. Jour., 1891, p. 778.

demonstrated. These pigs were killed after an incubation period of nearly 6 weeks, but no evidence of any lesions whatever could be observed, thus confirming the surmise that the nodules formed in the pigs inoculated with the heated milk were really due to the action of dead bacilli.

This phenomenon is attributable to the action of toxic substances inherent to the tubercle bacillus itself, and presumably would be more readily demonstrable in cultures of high virulence than in those more attenuated.

It is our opinion, therefore, as a result of this series of experiments that the virulent organism used was killed by the application of heat at the temperature of 160° F. when exposed in sealed containers.

These results therefore accord with those obtained in the preceding series, and lead us to draw the conclusion that a temperature of 160° F. or above, for a period of one minute, suffices to destroy the virulence of bovine tubercle cultures, so that the disease is not produced in experimental animals, like guinea pigs, inoculated with cultures ranging from 2 to 5 mgrs.

These conclusions are of course based upon laboratory experiments where the conditions have been more carefully controlled than is possible in commercial practice, yet it is our opinion that they approximate sufficiently the conditions that obtain in practice where continuous flow pasteurizers are used, to lay a proper foundation for a safe and efficient method of treatment of milk. If further testing of the thermal death point of the tubercle bacillus when exposed for short periods of time under varying conditions should demonstrate the correctness of the conclusion here presented that a temperature of 160° F. will destroy the pathogenic power of this organism, it will greatly facilitate the introduction of this method of control of milk supplies. This temperature limit, though, is so much below what has heretofore been found with this germ that the conditions of exposure must be varied as much as practicable and all possible variations incident to the organism itself must be studied before one unreservedly accepts this new limit for efficient pasteurization in a continuous manner.

STUDIES ON THE INFLUENCE OF THE SOIL ON THE PROTEIN COMPOSITION OF CROPS.

A. R. WHITSON AND C. W. STODDART.

There are two sets of factors which determine the composition of plants in general. The first are the inherited characteristics, or those which depend on the species or variety; and the second, those which are produced by the conditions under which the individual plant is grown.

It is, therefore, possible to influence the composition of the plant in two ways: First, by selection and breeding; and second, by modifying the conditions under which they are grown. Great stress is now being laid on the importance of selection and breeding of all kinds of crops, but except in the case of sugar beets, comparatively little attention is given to the influence which soil and climate have on their composition.

Tables of analyses of grains and fodders always show considerable variation in the composition of the same variety. This is especially the case with protein—the most valuable portion of the plant. The work of Mayer in Germany, Deherain in France, and of Woods and Soule in this country, has given us some knowledge of the influence of conditions on the composition of the seed, but the far greater variation in the composition of the vegetative portion of the plant has scarcely been noticed.

A consideration of the processes of plant growth will give a clue to this composition at different periods and under different conditions.

It is clear that the younger plant will contain greater relative amount of protein than the older, since the active cells of the leaves and of the growing portion of the stem are filled with

protoplasm of which the proteids are the characteristic compounds, while the older portion of the stem is largely made up of the cell walls of dead cells, containing very little protein. The plant which has a relatively large leaf surface will have more than the one with a relatively small leaf surface, and the one which is growing rapidly more than the one which is growing slowly.

There will be a gain, therefore, so far as a relatively large protein composition in fodders is concerned in using them in their younger stages, in planting them thinly enough to allow a good leaf development, and in having the ground fertile, so as to produce a rapid growth.

In the Annual Report of 1902 a summary was given of a preliminary study on the influence which the amount of available nitrogen in the soil has on the protein of the plant. This study has been continued the past year on material grown in the plant house, and a few determinations have been made on crops growing in the field. All determinations of protein have been made by the Stutzer method.

CROPS GROWN IN THE PLANT HOUSE.

The crops have been grown in the plant house on four plots, each about twelve feet wide and fifteen long. Three of these are of sand eighteen inches deep, lying on clay till subsoil. The fourth plot is of clay loam which has become extremely rich in nitrates as the result of standing in the warm plant house for several years. Of the three sand plots the first was watered with lake water containing no nitrates, the second with the same water to which a small amount of sodium nitrate was added, and the third with water containing double this amount. The fertilizer was added twice a week and in amounts calculated to maintain the second plot in a moderately fertile and the third in a very fertile condition with reference to nitrates.

Corn.—The corn planted July 15th on the three sand plots grew about equally in height, but there was considerable difference in color, that on plot 1 being lighter and showing by the dying off of the lower leaves, that it was suffering from lack of nitrate. That on plot 2 was moderately well colored, while

that on plot 3 had a deep green color throughout its growth. The corn on plot 4 grew more vigorously and reached a height of over nine feet, while the average height on the first three plots was seven and a half feet.

In taking the samples for determination of protein content six average stalks were selected from each plot and the entire stalks, leaves, and ears were chopped finely in the green condition. From this moist material a sample of 500 grams was taken, dried carefully in a water-oven and ground. Duplicate determinations of the proteid nitrogen were made and the results are given in the following table:

Table Giving the Per Cent of Proteid Nitrogen in Corn Grown in Plant-House.

	September 16	October 7.	November 7.
Plot 1	.62	.65	.66
Plot 2	.79	.74	.83
Plot 3	1.06	.80	.91
Plot 4	1.28	.92	.95

The corn on the first date was just coming into tassel and on the last date was at about the right stage to cut into the silo.

It will be seen from this table that the greater amount of available nitrogen in the soil has had a very marked effect on the protein in the plant, that in plots 2, 3, and 4 having about 25, 37, and 44 per cent more respectively than has that on plot 1. The differences in the fertility of these plots is no greater than occurs regularly in field conditions on different classes of soil and with differing degrees of care in management.

Rape.—On April 1st rape was planted on the three sand plots above mentioned and treated as described. The growth was proportional to the fertility and on June 3rd when samples were taken for protein determination the height on the three plots was 12, 18 and 20 inches respectively. The lack of available food material was shown by the yellowing of the lower leaves as well as by the poor growth on plot 1.

The determination of the protein gave 1.41, 1.46 and 1.73 per cent respectively.

Rape sown July 15, with the corn above mentioned and treated as there described gave the following results when determinations were made October 7th, Oct. 23rd and Nov.7th.

Table Giving the Per Cent of Proteid Nitrogen in the Dry Matter of Rape Grown in the Plant House and Receiving Different Amounts of Sodium Nitrate.

	Oct. 7.	Oct 23.	Nov. 7.
Plot 1	2.19	2.20	2.20
Plot 2	2.20	2.35	2.29
Plot 3	2.34	2.50	2.37

It will be seen that there is approximately five and ten per-cent more proteid nitrogen in the second and third plots respectively than in the first.

Sorghum.—Sorghum was planted on three sand plots April 1st. It grew well on all the plots but was a little darker in color on plot 2 than on 1, and on 3 than on 2. On July 16th, when samples were taken, the sorghum was heading out and was 6.1, 7.2 and 7.0 feet in height on the three plots respectively.

The determination of proteid nitrogen gave on plot 1, 0.778 per cent, on plot 2, 0.822 per cent, and on plot 3, 0.849 per cent. The difference in this case is not so great as in others and yet the sorghum on plot 3 contained 9.1 per cent more proteid nitrogen than that on plot 1.

CROPS GROWN IN THE FIELD.

Corn.—Corn growing on marsh soil of the University Farm has shown considerable inequality, as is usual on this soil. On some portions of the field the corn showed a strong growth with dark green and broad leaves, while on other portions it made a poor growth and was lighter in color. This, we have learned to recognize, is due to lack of available potash in the soil.

On August 30th samples of seven stalks each were selected from where the corn was making a good growth and from other places where the growth was not so good, the leaves being lighter

in color and relatively smaller, although the stalks were over six feet in height.

The leaves were stripped from the stalk, the ear "jerked" and each part cut up, dried and weighed after which the per-cent of proteid nitrogen in each part of each sample was determined. The total dry weight and percent of proteid nitrogen are given in the following table:

Table Giving Total Dry Weight of Stalk, Leaf, and "Jerked" Ear and the Per Cent of Proteid Nitrogen in Good and Poor Corn Growing on Marsh Soil.

	LEAVES.		STALKS		EARS.	
	Total dry weight.	Per cent proteid nitrogen.	Total dry weight.	Per cent protein nitrogen	Total dry weight.	Per cent proteid nitrogen.
Good corn..................	167.2g	1.72	313.6g	.34	705.6	1.10
Poor corn..................	91.1g	0.84	255.5g	.50	279.2	1.03

The most marked difference is, as one would expect, in the leaves, but the amount of the difference is surprising, there be more than twice as much proteid nitrogen in the same weight of leaves of the plant making a good growth, as in the one making a poor growth. The leaves and stalks taken together, in the case of the good corn, have 0.819 per cent of proteid nitrogen and in the case of the poor corn 0.589 per cent. This means that the leaves and stalks together of the good corn have 39 per cent more protein than the same weight of the poor corn.

The entire plant contains in the case of the good corn 0.902 per cent of the proteid nitrogen, while in the case of the poor corn it contains 0.785 per cent. This means that the good corn altogether contains about 15 per cent more protein than the same weight of the poor corn.

In a fodder of such low protein content as corn this is a matter of considerable importance. It means that not only does intensive farming secure larger gross yield per acre, but the crop is richer in the most valuable constitutent.

Sorghum.—Sorghum growing on a field of marsh soil adjacent to that on which the corn grew, showed a similar difference in appearance in different portions of the field, some parts, apparently where the soil lacked potash, being lighter in color and smaller than on other parts.

There was also a marked difference in relative amount of leaf, and some difference in color between the outer row and the inner rows. Three samples, each of seven average stalks, were selected Aug. 30th for the purpose of determining whether or not there was a corresponding difference in the protein content. The leaves were stripped from the stalk, but the seed left on. The entire material was chopped up till fine and dried. A sample was then ground for protein determinations. The dry weight and per cent of proteid nitrogen are given in the following table:

Table Giving the Dry Weight and Per Cent of Proteid Nitrogen in Sorghum.

	LEAVES.		STALKS.		
	Total dry weight.	Proteid nitrogen.	Total dry weight.	Proteid nitrogen.	Nitrogen entire plant.
	Grams.	Per cent.	Grams.	Per cent.	Per cent.
Outside row	139.5	1.93	564.8	0.676	(0.924) 21
Inside row..........	82.1	1.74	363.4	0.472	(0.765) 21
Poor	50.6	1.07	92.9	0.360	(0.612 51

It will be seen that not only is there a larger per cent of proteid nitrogen in the leaves of the plants growing on the outside row, but the ratio of leaves to stalks is greater. While the stalks of the outside plant weighed 4.0 times as much as the leaves, the stalks of the inside weighed 4.4 times as much as the leaves.

Comparing the stalk of the sorghum with that of the corn it will be seen that while there is a larger per cent of proteid nitrogen in the stalk of the poor corn than in that of the good, there is a larger percent in the outside stalks of sorghum than in the good inside stalks, and more in the latter than in the poor

stalks. This difference is due partly to the fact that in preparing the samples the seed of the sorghum went with the stalk while in the case of the corn it was determined separately, and also partly to the large amount of non-protein material in the seed of corn as compared with that of sorghum.

Comparing the per cent of proteid nitrogen in the whole plant of sorghum, it will be seen that the outside plants had nearly 21 per cent more than the good inside plants, and 51 per cent more than the poor plants, while the inside good plants had 25 per cent more than the poor.

Conclusion.—From the foregoing data it is evident that the relative amount of protein in the plant is subject to very marked variations dependent on the conditions under which it is grown. The fertility of the soil is undoubtedly one of the important conditions, in respect to nitrates especially, but also, in all probability, in respect to availability of the other essential elements.

From the determinations made on the sorghum in the field it also appears likely that closeness of planting is an important factor; the more space the plant has to develop in the greater is the ratio of leaves to stalk and hence the greater the amount of protein it contains.

STUDIES OF MUCK AND PEAT SOILS.

A. R. WHITSON AND C. W. STODDART.

Drainage and Temperature.—The first step in the improvement of marsh lands is their drainage. Not only is it necessary to have the land drained so it can be worked but also to allow it to become sufficiently warm to permit of the rapid growth of crops necessary in a region of so short a season as ours.

This matter of the temperature of marsh soils is one of extreme importance. Not only does the coldness of insufficiently drained ground prevent the growth of the crops but it is the cause of frost whenever the general temperature of the region becomes low. It is a well known fact that frost occurs on low ground and in hollows when the temperature of adjacent higher land is as much as eight or ten degrees above the freezing point. But there is an opinion prevalent that this is largely due to the settling of the colder air into the low places. Recent observations, however, especially on the peat lands of the central part of the state, have shown that the temperature of the soil itself is the largest factor in determining the formation of frost, and that this temperature is determined largely by the drainage conditions but also in part by the character of the soil and the vegetation on it.

While this matter is discussed at length in the report on cranberry growing, see page 232, it is desired to call attention to it here on account of its great importance in the raising of all crops which are injured by frost. When it is realized that frost can be to a considerable extent controlled by drainage this will be an additional incentive to such drainage. It is not

our intention, however, to take up here the discussion of the practical work of drainage. That will be done in a later publication.

Fertility of Marsh Soils.—So essential is humus to fertility of the soil and so large is the amount of humus in many of the most fertile soils that there is a strong tendency to think that all soils which have a large amount of humus must be fertile. But when we remember that there are a number of conditions necessary to a fertile soil and that a failure in any one of them makes all the rest of no avail, we can understand that two soils may look alike while there is really a great difference. This is the case with the marsh soils. Many of them are very fertile, while others are quite unproductive in their natural condition.

Relation of Humus to Subsoil and Vegetation and Size of Marsh.—The humus in any soil, whether marsh or upland, bears a close relation to the soil. Limestone in soil tends to decay humus. Again those plants which grow on limestone soils are more tender and rank and subject to decay. Again the clay of a fine soil is more easily carried from higher land onto the marsh and mixed with the decaying vegetable matter. Then, too, small marshes are more subject to surface wash than large. Since the vegetation is related in composition to the soil on which grown, the humus resulting from its decay is also related in chemical composition to the soil.

All these factors go to produce differences in marsh soils and the result is what we find in the marsh soils of Wisconsin a great diversity in physical and chemical composition. It is therefore not an easy matter to describe the marsh or humus soils. There are however two fairly well defined classes of marsh soils in Wisconsin: (1) muck, usually found on clay subsoil and (2) peat, in most cases found on sand subsoil. These classes of soils are distinguished by marked differences in the respects above mentioned. The first are commonly and properly known as *marsh* soils while to the second class the term *moor* soils is more applicable.

In general the vegetable matter in the marsh soils has undergone a considerable amount of decay; while in most cases the

vegetable material of the moor lands is in the form of peat. These two types of soil are so different that they will be discussed separately. It is true that there are some cases where the subsoil is a very fine sand or silt and where the humus is between these types in composition; but on the whole the classes are fairly well marked.

I. BLACK MARSH OR MUCK SOILS.

Drainage Conditions.—On account of the impervious nature of the clay underlying most of the soils of this class and of the very great capacity which they have for water, artificial drainage is necessary to render them tillable. The drainage of these soils, however, is much more difficult than of the peat soils underlaid by sand. While there are comparatively few areas which do not have sufficient fall to allow water to run when tiled, the imperviousness is usually so great as to render it necessary to use tile to make the drainage satisfactory. The distance apart of the tile will vary from fifty feet where the clay is quite impervious to eighty or one hundred feet where there is more or less sand in the subsoil. It must always be remembered that the character of the subsoil is the most important factor in determining the distance apart of lateral tiles and hence of the cost of drainage. Without discussing the expense here in detail it may be stated that the cost of good tile drainage of these marsh soils on clay subsoil will vary from twelve to twenty dollars per acre.

With the high price of land in those parts of the state where most of this land is located the benefits derived are undoubtedly sufficient to warrant the drainage of a large part of this class of lands.

Fertility of Muck Soils.—On account of the very large amount of humus which these soils contain and their fine texture, they have the appearance of being very fertile. Except in very limited areas, they are usually fairly productive during seasons when the rain fall is not so great as to cause undue wetness of the soil. There are, however, patches varying from a few square rods to several acres in extent, in most of the areas of this land, which are extremely unproductive. This lack of

fertility is noticeable especially when corn, potatoes and oats are growing on the ground. This lack of fertility has been studied by Professors King, Jeffery and Whitson and the results reported in Bulletin No. 80 and in the annual reports of the four years past. A summary of these reports was given in the last annual report, and without going into detail it will suffice here to say that the results of this work show that these black marsh soils in the southern part of the state, where unproductive, are in need of potash. While there are a few cases which do not seem to be improved by an application of this fertilizer, it is probably true that by far the greater part of these patches of ground are in need of potash alone to make them productive. This can be supplied in the form of potassium sulphate, spread broadcast and harrowed in at the rate of 150 pounds per acre when preparing the ground for planting. Farm yard manure in moderate quantities, especially coarse horse manure, is also very beneficial, although it would ordinarily be better practice to use the artificial fertilizer on the marsh soils and the manure on upland soils, in cases where the farm comprises both classes.

Chemical Composition.—In order to determine whether this apparent lack of potash is due to its existence in the soil in an unavailable form or to its actual absence, analyses have been made of the surface six inches and of the surface foot of this soil from a field on the University Farm on which the corn shown in Fig. 36 was grown. The rows of corn on the left of the figure were treated with potash in small amounts while those on the right were left without potash treatment, the samples of soil being taken from the latter rows. It will be seen from this figure that a very great improvement was effected by a moderate application of potash. The analysis of the surface six inches shows the following results:

FIG. 36.—Showing effect of potash on corn growing on black marsh soil.

Analysis of Surface Six Inches of Marsh Soil on the University Farm.

	Per cent.
Calcium oxide	2.252
Magnesium oxide	1.483
Phosphoric acid	0.270
Potash	0.176
Nitrogen	0.514
Insoluble residue	69.452

It will be seen from this analysis that while calcium, magnesium, and phosphoric acid are present in abundance the potash is somewhat smaller in amount than in the majority of fertile upland soils. When we consider, in addition to this, the small specific gravity of this soil, it will be seen that the amount of potash in the surface six inches is not more than one half that of ordinary fertile soils. Nevertheless, there is present 1330 pounds of potash in the surface six inches of an acre of this soil. The analysis of the surface foot shows the following results:

Analysis of Surface Foot of Marsh Soil from the University Farm.

	Per cent.
Calcium oxide	1.821
Magnesium	1.465
Phosphoric acid	0.227
Nitrogen	0 351
Insoluble residue	72 811
Total potash	1.429

The above determinations were all made by digesting the soil in sulphuric acid in order to effect the decomposition of the large amount of organic matter, except that the potash of the last sample, taken to the depth of one foot, includes the total amount of potash as determined by the J. Lawrence Smith method. From the data in the foregoing it seems evident that while the potash in the form soluble in sulphuric acid is small there is still so large an amount present that it must exist in an insoluble form, probably in combination with the humus.

It will be seen from the above analysis that the amount of magnesium oxide is large compared with that found in the ordinary soils, and it is possible that in some of these soils this may accumulate in sufficient quantities to be injurious and this may explain the two or three cases known in the state where potash has not seemed to improve the condition of infertile patches of these soils.

Use of Clay.—In as much as these soils are usually underlaid by clay, which contains considerable potash, it would seem that the use of this clay in the form of a surface dressing might greatly benefit the soil. Indeed, it is rather a common practice in Europe, particularly in Bohemia, where a similar clay is found, to dig ditches through the land, from the bottoms of which the clay is thrown over the surface of the ground and it is said that this treatment is very beneficial. An experiment of this kind was made at the University Farm, in which clay at the rate of twenty tons per acre was scattered over the surface in the spring of 1903; but no improvement was shown either this year or last. It is quite probable, however, that where the soil is more peaty than that on the University Farm this treatment would be helpful, especially in securing a better growth of grass.

Acidity.—It is generally true that marsh soils have an acid reaction on account of the large amount of humus which they contain. The marsh soils in the southern part of Wisconsin, however, are not strikingly acid, perhaps on account of the fact that they are underlaid and surrounded by glacial till, containing large amounts of ground limestone which is gradually dissolved and is carried out into the marsh, thus in part neutralizing the acidity as it is developed. The effect of liming marsh soils in general will be discussed in connection with the peat land to be described later.

Crops Adapted to Muck Soil.—The difficulties with which the farmer on muck soils has to contend are, the wetness in the spring, the danger of frost on the low land, and the over abundance of nitrate which develops in midsummer.

Even when tile drained, so great is the capacity of these soils for water that they are often too wet to allow sowing the cereals in proper time. The large amount of nitrate often causes oats and other cereals to lodge badly and not fill well and this also makes the soil poorly adapted to these crops in general, although when the season happens to be favorable they produce well.

When treated with potash where needed, or well manured, this soil produces good crops of corn and potatoes and is especially adapted to cabbage, rape and celery. But the danger from frost on the low ground is considerably greater than on upland soil, even after drainage. This soil, however, is well adapted to the grass crops which use more water than any other farm crop, do not require spring tillage, and are not affected by frost.

With this in mind a preliminary study has been made of some of the grasses which seemed best adapted to this soil. The ground selected was a plot of black marsh soil of the University Farm. The grasses tried so far have been: Tall Meadow Oat, Meadow Fescue, Red Top, Timothy and Alsike clover, Fowl Meadow and Brome. Of these Timothy, Fowl Meadow and Brome have given the best results this year. Timothy and Alsike clover sown early in the fall of 1903 gave an extremely heavy yield this year. On land not subject to overflow for

more than a few days in the spring, a mixture of Timothy and Alsike clover is probably as good as any for hay, the only trouble with Timothy being the tendency it has of becoming woody when grown on marsh soil. The plot of Timothy and Alsike clover is shown in Fig. 37.

FIG. 37.—Showing timothy and alsike clover growing on black marsh soil the first year after seeding.

Brome grass, although usually grown on upland soil and especially adapted to a region of light rain fall, has been found to grow well on borders of the plot where it has been growing several years. This observation led us to make a trial of it on one of the plots. It was sown at the same time as the Timothy and has done well this year, although the stand was light owing to poor seed. While this grass is somewhat harsh when grown on upland soil, it is very fine and tender when grown on marsh soil. Although this experiment can, so far, only be considered preliminary it seems to indicate that Brome grass will prove to be a valuable grass for this soil. This plot is shown in Fig. 38.

FIG. 38.—Showing Brome grass (*Bromus inermis*) growing on black marsh soil the first year after seeding.

Fowl Meadow grass grows native on these soils in many parts of the state and is undoubtedly hardy under their conditions. It is, however, a fine grass and may not yield sufficiently heavy to justify its use. Seed sown early in the fall of 1903 made good growth this year, although it will need two or three years to thoroughly occupy the ground. On account of the desirability of making more trials with this grass and the fact that it is almost impossible to secure the seed on the market, this grass was allowed to go to seed. A view of this plot is shown in Fig. 39.

It would seem that from all considerations this soil is well adapted to grass crops raised for hay. It must be recognized, however, that these crops are constantly taking the plant food material from the soil and that it will need top dressing with manure or other fertilizer to keep on giving large yields.

FIG. 39.—Showing fowl meadow grass (*Poa serotina*) growing on black marsh soil the first year after Seeding.

II. PEAT SOILS OF MOOR LANDS.*

The soils of this class are different in may respects from the marsh or muck soils on clay subsoil described above, and can only be understood when these differences are distinctly recognized. These differences are in respect to drainage conditions as well as in respect to composition and fertility.

General Description and Distribution.—These soils consist of more or less coarse, fibrous peat forming areas of considerable size on sand. The peat varies in depth from a few inches to ten or twelve feet and more in some cases. In consistency it varies all the way from a very coarse, raw peat through various stages of decomposition to that of muck. The coarse condition peat is that found over by far the greatest extent of territory. The sand by which this peat is underlaid is a rather coarse, very highly silicious sand derived from the Potsdam

*This being the first year that attention has been given to the peat soils this portion of the report is to be considered as preliminary only.

sandstone on the outcrop of which the largest part of this class of soils is found. In a few localities, on areas varying from a few acres up to two or three sections in extent, this soil is underlaid by a clay resulting from the decomposition of granite over areas from which the sandstone has been eroded. Along streams there is often found an intermixture of fine silt brought down by the stream with peat so as to produce a soil of considerably greater fertility than this type of soil generally has. These peat soils occur to a considerable extent in the southern part of Portage and Wood Counties, in Jackson, Monroe and Juneau Counties in the central part of the state and in the northeastern part, in smaller areas in Oneida, Vilas, Oconto, and Marinette, and in the northwestern part in Burnette and Washburn, and in larger or smaller areas in other parts of the northern half of the state. This peat owes its origin very largely to sphagnum moss, which is still growing over the moister portions of the marsh.

Drainage Conditions.—The drainage conditions of these peat or moor lands are quite different from those of the muck soils heretofore described. For the most part the peat soil lies on a sand plain, having a slope of from three to six feet per mile toward the larger streams. While these lands are usually very wet in the spring and when the snow is melting and are flooded by heavy rains, a sufficient drainage can usually be secured by the use of open ditches large enough to remove the surface water rapidly and having a depth in the sand such as to withdraw the excess of ground water which it contains. On account of the very great water holding capacity of this peat, these lands are not damaged by heavy rains coming later in the season, the important point being, however, to get them drained early enough in the spring to allow the soil to become warm for the growing of crops.

It is our purpose to discuss the drainage of this land in another place, and we will, therefore, not go into the details of the matter here. It is desirable, however, to call attention here to the fact that most of the main ditches which have been constructed in the large drainage districts so far organized, are

too small to carry off large volumes of water which collect on this land, especially from the melting of snow in the spring.

Fertility of Peat Soils.—On account of insufficient drainage these lands have not been cropped to any extent in the past, and the little they have been cultivated has been during the occasional dry seasons. It has, therefore, been difficult to estimate their fertility under continuous cropping. After the fires, to which these lands are subject during seasons of drought, very heavy crops especially of Timothy have been raised the first year. Very few cases are known to the writer, however, where successive crops have been raised on typical peat soil. The few cases where these lands have been drained and cropped for a few years, have shown that where they are not fertilized there is a very marked falling off in yield with each crop removed from the ground, and after three or four years the crops have been unprofitably small.

Field Experiments.—For the purpose of making a careful study of these soils a piece of land about six acres in extent has been leased at Marinette on the farm of Mr. J. Murray Andrews. This soil is a medium coarse peat from three to four feet in depth underlaid by coarse sand. The ground is plowed in lands eight rods in width with ditches on each side, three feet in depth, to draw the surface water and part of the ground water. Four acres of this land had been cropped for three years preceding the present crop.

In 1900 it was broken and at once seeded to Timothy, of which a heavy crop was secured in 1901, The second year, 1902, the growth of Timothy was very light and the ground was again broken and planted to corn in 1903. Partly on account of the extreme wetness of this season, but undoubtedly also on account of the lack of fertility in the soil, this crop of corn was very poor. Indeed, it was not deemed of sufficient value to be cut. It is evident from this experience that this piece of land is greatly lacking in fertility with reference to one or more elements. The ground this year was laid out for experimental purposes into a number of plots to be used in determining the crops to which the soil was best adapted and the fertilizing elements most lacking.

Our experience in the Southern part of the state on the marsh soils above described led us to suppose that this soil also would be especially deficient in potash, and our plans for experimenting in the field were chiefly with reference to this element. One half of the field was divided into plots for testing a number of grasses for hay production, and the other half was used for cultivated crops, including corn, potatoes, rape, squash and sugar beets. Plots on both parts of the field were treated with sulphate of potash at the rate of 136 pounds per acre; others with the Star brand of phosphate at the rate of 160 pounds per acre, and still others with a very light dressing of horse manure.

The spring was remarkably late and the entire season has been cold and backward, thus making it impossible for part of these crops to do well, even if the soil had been sufficiently fertile. The corn was killed by a heavy frost in August, thus making it impossible to determine what the result would finally have been. It indicated, however, at this time, that the manure and potash had been helpful. This indication is also borne out by the sugar beets and potatoes, although at the pressent writing, these have not been dug. It is evident that the light application of phosphate was not sufficient to determine whether or not this element would have been beneficial.

Greenhouse Experiments.—In order to have a more carefully controlled experiment on the fertilizer test of this soil, several barrels were brought to the greenhouse and used in pot experiments.

This peat was taken from a field which had never been cropped. Two experiments were made on it in the greenhouse, first with reference to the availability of the mineral elements, and second, with reference to the amount of acidity and the influence of an application of lime. The first crop of corn grown on the peat in four gallon jars, treated with potash and phosphoric acid separately, showed a very marked benefit from the phosphoric acid but none whatever from the potash. Fig. 40 shows this first crop. The corn on the jar which had been treated with phosphoric acid, made a very vigorous growth apparently having all the food materials it could make use of.

FIG. 40.—Showing first crop of corn grown on peat soil. Jar No. 16—no treatment; No. 9—potash; No. 6—phosphoric acid.

The second crop of corn grown on these jars with the same treatment repeated gave an entirely different result. While the corn with potash treatment grew somewhat better than the unfertilized one, the one to which the phosphoric acid had been added grew no better. This indicates that there is probably a sufficient supply of food materials for a single crop of corn, except of phosphoric acid in the virgin soil, but that both potash and phosphoric acid must be added after the first crop has been removed.

Another test of this matter was made by placing peat in galvanized iron cylinders, 18 inches in diameter and 42 inches in depth, the peat being 2½ feet in depth on sand placed on the bottom. The first crop of corn was grown without treatment of any kind and was comparatively poor. This was removed at the end of five weeks and a second crop planted with the result shown in Fig. 41. Cylinder No. 5 was treated with potash, No. 6 with phosphoric acid and No. 7 with both. It will be seen that while phosphoric acid is more helpful than the potash they are both required for satisfactory growth.

Considering the result of these experiments together with the

FIG. 41.—Showing second crop of corn grown on peat soil. Cylinders 5, 6 and 7 treated respectively with potash, phosphoric aicd and the two together.

field experience, it indicates that these soils will require applications of both potash and phosphoric acid to make them productive.

Acidity and Use of Lime.—It is a well known fact that peat soils usually have a very decided acid reaction. This is especially the case where these soils are developed on sand containing a very small amount of lime as in the case of a large part of the soils of this class in Wisconsin.

In order to estimate the amount of lime which is necessary to correct this acidity, we have used a modification of Tacke's method suggested by H. J. Wheeler.

In this determination we have used forty grams of soil mixed with five grams of calcium oxide and 200 cubic centimeters of water. This was boiled until only water came over, and the CO_2 was weighed. A correction was made for the CO_2 set free from the soil and water when boiled together without the calcium oxide. The result of this determination showed that this peat from Marinette required 3642 parts of calcium oxide per million of soil in the field condition to neutralize the acid. The soil contained 78 per cent of water. This would require three and a half tons per acre to neutralize the soil to a depth of six inches.

Two tests were made of the accuracy of this determination by applying different fractions of the indicated amount of lime to samples of moist peat placed in greenhouse jars. In the first experiment quantities varying from one half to twice the calculated amount were used and in each case the lime was intimately mixed with the peat. The experiments were begun on the 23rd of May and tests were made from time to time until the 6th of June. On the latter date the peat having twice the calculated amount of lime showed that the acid had probably been more than neutralized since it was strongly alkaline to red litmus paper, while those receiving less than the calculated amount were still acid. The one receiving the calculated amount was practically neutral.

The second examination was made on three four-gallon jars of the peat, the first having one half the calculated amount, the second just the calculated amount and the third one and a half times this amount. The experiment was started May 21st and allowed to run until August 4th. On this day tests with sensitive litmus paper showed that the one which was treated with the calculated amount seemed very nearly neutral, and the one with one half of this amount distinctly acid, while the one with one and a half times this amount was distinctly alkaline. It would seem, therefore, that this soil probably requires the

above mentioned amount of 3½ tons per acre to neutralize the soil.

Effects of Acidity.—There are two ways in which the acid of soils may influence the growth of plants in them: It may affect the plants directly or it may affect the amounts of mineral elements of certain kinds which are made available to the plants. It is not always a simple matter to distinguish these from each other, and it is very probable that they have frequently been confused by students of soil fertility. Field experiments made this season on the application of lime did not indicate that any of the grasses, corn or potatoes were benefited by the application of lime, although it should be stated that the lime was added in the spring not long before the planting, instead of the season before, as is the common practice. Plant house experiments gave essentially the same results with corn, oats and Lima beans. In Fig. 42 is shown a series of four jars,

FIG. 42.—Showing corn grown on peat soil treated with different amounts of lime.

of which all are treated equally with phosphoric acid. No. 6 was without lime, No. 1 was treated with the amount estimated to neutralize the acidity, No. 37 with one half this amount and No. 29 with one and one half times this amount. It will be seen that while the plants are not quite equal in growth, the one without lime is better than the one having the largest amount. In Fig. 43 is shown a series of jars of oats

in which No. 26 is without lime, and the amount of lime increased from one third the amount necessary to neutralize the acid in No. 36, to twice that amount in No. 11. Again it is evident that there is no essential gain from the use of lime on the peat so far as neutralizing the acid alone is concerned. While it will be necessary to subject this matter to a longer study before positive conclusions can be drawn, it certainly appears doubtful if the large applications of lime necessary to neutralize the acid in this soil is warranted, so far as the correction of any injurious effect of the acid itself is concerned. The

FIG. 43.—Showing oats grown on peat soil treated with different amounts of lime.

fact that large crops have been grown on this soil following an application of farm yard manure, and very great improvement produced by the application of phosphate and potash without lime, would indicate that for most crops liming is not necessary. It is, of course, possible that certain crops may require liming on this soil. This is a matter which requires further study.

Influence of Liming on Nitrification.—The very large amount of nitrogen which this peat soil contains is, of course, not available to crops in its present form and becomes available only after the process of nitrification has taken place. This process it the result of the action of nitrifying bacteria, which are supposed to require either a neutral or slightly alkaline solution for their activity. Not only is this action of the bacteria

necessary to the nitrification, but there must be present sufficient quantities of mineral bases to combine with the nitric acid to form nitrates. It would seem, therefore, that an application of lime would be necessary to this process in these soils. A study of this has been made both in the laboratory and in the field.

Four 4-gallon jars were filled with the peat immediately after it was brought from the field. The first was left without lime, the second was mixed with one fourth the amount necessary to neutralize it, the third with just that amount and the fourth with one and three fourths times that amount. These jars were kept in a moderate condition of moisture in the plant house during the summer. Determinations were made of the amount of nitric nitrogen in parts per million of dry soil at the time the experiments were started May 23rd, on July 8th and August 26th, with the results given in the following table:

Table Giving the Amount of Nitric Nitrogen in Parts per Million of Dry Soil Formed in Peat Treated with Different Quantities of Time.

AMOUNT OF LIME ADDED.	PARTS PER MILLION OF NITRIC NITROGEN.		
	May 23.	July 8.	Aug. 26.
0	18	145	891
¼ calculated	18	449	1,055
1 calculated	18	411	1,532
1¾ calculated	18	760	2,106

It is evident from this experiment that the application of lime has a very marked effect on the amount of nitrates produced, but it is also evident that without any lime whatever the amount of nitrates developed is very large. Indeed, the amount developed in the jar without any lime is larger than that formed in any fertile clay loam soil of the University Farm.

Samples taken from fallow plots in the field Sept. 3rd on the unlimed portion contained 3.28 parts of nitric nitrogen per

million of dry soil. This means that the unlimed part had 450 pounds of available nixtrogen per acre or five times the amount necessary for a heavy crop of corn. It is evident therefore, that it is entirely unnecessary to add lime to aid nitrification in this class of soils.

SUMMARY OF CONCLUSIONS.

1. The marsh soils of Wisconsin belong to two distinct types: (1) the black marsh or muck soils usually underlaid by clay and (2) the peat or moor soils usually underlaid by sand.

2. The black marsh soils are fertile except in comparatively small areas where they require potash.

3. The peat soils especially where underlaid by sand will require both potash and phosphoric acid or an application of manure to make them productive.

4. The results of the experiments made this summer do not indicate that the use of lime on this soil will be especially beneficial. This is a matter, however, which needs farther study.

5. These soils are adapted, on account of the large amount of nitrogen they contain, to such crops as corn, rape and the hay grasses. The danger of injury from frost, however lessens somewhat their adaptability to corn.

6. The injury from frost can be greatly lessened by drainage.

PRELIMINARY REPORT ON CRANBERRY INVESTIGATIONS.

A. R. WHITSON, E. P. SANDSTEN, L. P. HASKINS AND H. J. RAMSEY

The legislature of 1902–03 passed an act May 10, 1903, appropriating the sum of $2,500 per year, for two years, to aid in the development of the cranberry industry of the state, and in carrying on lines of investigation pertaining thereto. The work was placed under the direction of the departments of Agricultural Physics and Horticulture. In addition to this, we have secured aid from the general government, and the study of the use of water in cranberry growing has been carried on in co-operation with the Division of Irrigation and Drainage of the Department of Agriculture.

After looking about for a suitable tract of land for cranberry growing and experimental purposes, it was decided to accept the offer of the Wisconsin Cranberry Growers' Association of their station for a nominal consideration, and a lease was executed for a period of fifteen years, at the option of the University of Wisconsin. This station is located in the center of a large and important cranberry growing section about eleven miles southwest of Grand Rapids, and four miles north of Cranmoor, a station on the C., M., & St. P. R. R. The tract consists of about ten acres, a small portion being somewhat elevated above the general level of the marsh. Upon this elevation a two-room cottage was erected, serving as an office and room for the attendants.

The Cranberry Growers' Association had growing on this station some one hundred and fifty so-called varieties of cranberries collected from different parts of the world. These and

other cranberry vines were included in the deed. Thus it will be seen that the University was materially aided by having a large amount of this pioneer work started.

Due to the lateness of the time at which the bill was passed, little but preliminary work could be done the first year. It was necessary to get the marsh into a suitable condition for planting and experimental work. The problem of adequate drainage and water supply had to be solved. Ditching, scalping, sanding had to be done preparatory to the investigational side. Most of this preparatory work was finished at the beginning of the present season.

A general view of the Cranberry Experiment Station, as seen from the tower in the reservoir, is given in Fig. 44. It is our expectation to publish in the form of a bulletin, to be issued in the near future, the results of all the work so far done and the following pages are intended only as a general discussion of those phases of the industry which have attracted our attention.

CONDITIONS REQUIRED FOR CRANBERRY GROWING.

Raising cranberries, like raising all other small fruit, is a very intensified industry, that is one requiring a large expenditure of capital and labor on a small area of ground. Moreover, success is usually proportional to the ratio between the expenditure and the ground upon which it is expended. It is, therefore, of the utmost importance that the location be carefully selected in order to allow the grower to have as nearly perfect control over these conditions as possible. The conditions essential for successful cranberry growing, are, first, a proper soil; second, a sufficient supply of suitable water; third, adequate drainage; fourth, suitable topography for handling water; and fifth, accessibility to railroad and other means of communication.

FIG. 44.—View of the State Experiment Station, near Cranmoor, showing a corner of the reservoir and the complete system of dykes, and flooding and drainage ditches.

SOIL.

The cranberry plant will grow on a wide variety of soils, but the character of the soil has a great influence on the character of the plant and amount of fruit produced. When grown on clay or other fertile soil, the plant usually makes a heavy growth of vines without fruiting well, and this class of soils is also apt to produce a heavy growth of weeds which are expensive to eradicate, and endanger the cranberry itself. This fact makes it desirable to grow the cranberry on sand, light muck or peat. Of these, peat is by far the most desirable and is the chief soil on which cranberries are raised. The peat is best adapted to this plant because of the topography, which is usually admirably adapted to the use of water, and because it is so easily ditched and affords good material for the construction of dams and dykes.

The peat varies in depth and coarseness from a few inches to ten or twelve feet, or even more, and through all stages of decomposition from a coarse, loose condition of the sphagnum moss, from which it is very largely formed, through the finer and more compact forms of peat to the decomposed form or muck. The growth of the cranberries and the fruiting are very largely influenced by the character of the peat on which they are grown. In general, the coarser and deeper the peat, the more rank and vigorous is the growth of the vines. It is possible that the fruiting is not quite so heavy on these coarser grades of peat, but certainly in many instances extremely heavy crops have been raised on very coarse peat. It is desirable that the soil of the whole of each plot be of a uniform character, both as to depth of peat and texture; the first in order that there may not be unequal settling of the ground, leaving it uneven, and the second, in order that the berries may come to maturity at the same time over the whole plot.

WATER SUPPLY.

While it is true, as will be shown later, that cranberries are very much less likely to be injured by frost when grown

on soil that is well drained than on soil that is continually moist, it is, nevertheless, necessary that they be protected from severe freezing and from winter killing by flooding with water. The use of water is, also, necessary in getting rid of some insect enemies of the plant and a sufficient supply of water is, therefore, a prime requisite in cranberry growing.

Amount of Water to be Used.—The amount of water necessary depends, first, on the amount used for flooding and, second, on the unavoidable loss in storage, by evaporation and seepage. It is usual to cover the vines during the winter to a depth of one foot, and on the average it is probably necessary to flood from twelve to fifteen times during the Summer winter. If three inches of water are used at each flooding, this would require at least four feet over the area covered with vines for flooding purposes alone, in addition to what is lost by evaporation from the storage reservoir.

Character of Water.—There is perhaps as little known in respect to the influence of the character of the water on the cranberries as in any other part of the cranberry industry. It is generally believed by cranberry growers that the water must be entirely soft, that is, without lime carbonate, as this is supposed to be injurious to the plant. While this is a matter needing further study, it is still true that the water over practically all of the regions adapted to cranberry growing is extremely soft, being largely surface water from either sandstone or granite, the soil of which contains only very small quantities of lime carbonate. In order to determine whether the presence of lime carbonate in the water would be injurious to the cranberry, we have made an experiment by spreading a thin layer of marl, which is almost pure lime carbonate, over a part of one of the plots. This application was made in the early summer of the present year and no influence was apparent in the growth of the vine during the season, nor in the yield of berries.

Another matter of importance in respect to water used, is that of freeness from the seeds of weeds. It is very generally found that water from lakes or ponds surrounded by a thick growth of vegetation is liable to carry the seeds of these

plants on to the cranberry marsh, thus considerably increasing the expense of keeping the marsh clean.

Source of Water.—From the above it will be seen that the source of the water should be, first such as give a constant and sufficient supply with as little expense as possible, second of the proper character, that is as free from hardness and seeds of weeds as possible. Where other conditions are right, the best and most economical source of water would undoubtedly be that of constant streams. Indeed, by far the most common location of cranberry marshes in Massachusetts and New Jersey is in the shallow valleys of the small but reliable streams. In general, however, we do not find the best soil and most uniform topography in such locations in our state, and while it is doubtless true that there are many places where shallow valleys along such streams can be utilized for cranberry growing, by far the majority of cranberry marshes at present are on broad, moor-like areas where the water in the small streams is inadequate in amount for cranberry culture. In these locations the supply from streams must be supplemented by the collection of surface water from the melting snow and summer rains.

Storage of Water.—Since, as was above stated, the land most suitable for cranberry culture is not adjacent to streams of sufficient size to supply them with water at all times, especially during a dry season when the streams are apt to dwindle and even disappear, the storage of the flood water in the spring and the rain water in the summer becomes necessary.

The selection of the situation for cranberry growing is, therefore, very greatly influenced by the conditions influencing the storage of water. Of course, the expense of storage reservoirs depends chiefly on the length of the dam which it is necessary to construct. In many cases it would be a comparatively small matter to construct dams across the outlets of small lakes, thus turning them into reservoirs, but the number of suitable locations where the ground below is adapted to cranberry growing seemed limited, although no survey of such locations has as yet been attempted. At present the cranberry marshes on the moor lands are supplied with water from reservoirs constructed by throwing dams across the line of fall of the land and wings at

right angles thereto, thus forming pockets into which the water is collected. An example of such a dam is shown in Fig. 45 taken from a photograph of the Elm Lake Cranberry Co.

FIG. 45.—Reservoir of the Elm Lake Cranberry Co.'s marsh, showing floating peat bog above the open water in the reservoir.

Depth of Water in Reservoir.—The depth to which it is possible to raise the water in such reservoirs depends upon the slope of the ground and upon the permeability of the soil itself.

It is, of course, desirable that the water in the reservoirs be held at a considerable depth in order to limit the loss by evaporation as well as to decrease the amount of land it is necessary to use for this purpose. Where small lakes can be made use of there would be no difficulty in increasing the depth on account of seepage through the bottom, since the bottoms have already become practically impermeable. Where it is necessary to construct reservoirs on the open moor lands the depth to which the water can be held depends upon the local conditions of the

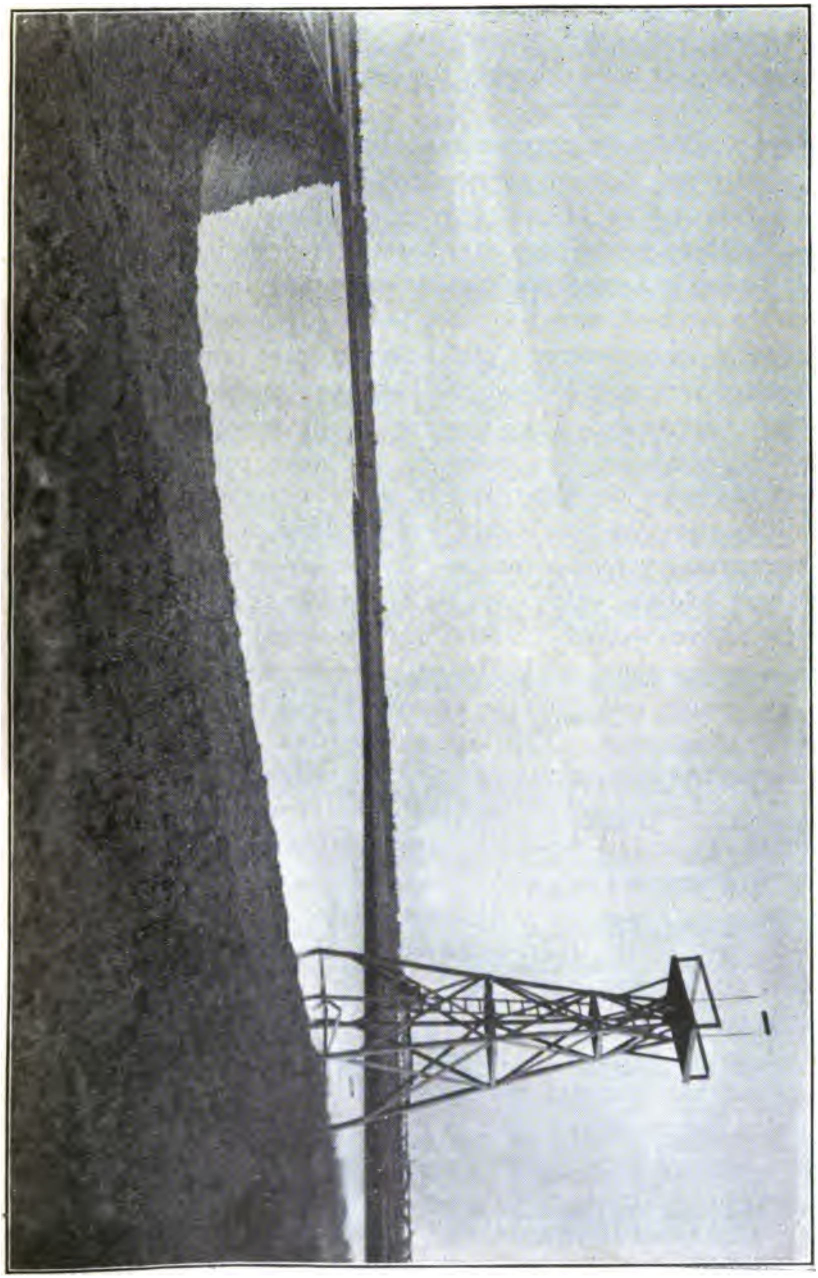


FIG. 46.—Station reservoir, showing construction of peat sod dam. Ananometer and wind vane tower on the right.

depth and permeability of the peat, as well as on the fall of the land which is available for such use. When the depth of water in the reservoir is considerable, the loss by seepage through the bottom is often very great.

Loss of Water By Seepage and Evaporation.—In the reservoir constructed at the experiment station and shown in Fig. 46 where two cuttings of peat were removed and the peat over sand was thereby reduced to a thickness of from six inches to two feet, the loss by seepage amounted to about three inches per day, when the depth of water was three feet. It is possible that the bottoms of such reservoirs can be made more impervious by hauling on sand to hold down the loose peat, thereby rendering it more impervious. This, however, would be expensive, and probably cannot be used except on the lower portions of the larger reservoirs where the depth of water is greatest. In such localities where the peat is thin, and the depth of water cannot be very great a succession of dams thrown across the fall of the land will hold the water in as shallow sheets as may be necessary to prevent seepage. It must be remembered, however, that spreading the water out in this way greatly increases the loss by evaporation, both from the water itself and from the vegetation growing on it. This loss by evaporation will average about two feet between May 1st and November 1st.

It is evident, therefore, that the depth of water which it is desirable to hold is dependent upon local conditions and can only be determined by careful observation as to the seepage or loss from the reservoirs at different heights of water. It will be necessary for the owner to determine what the loss by evaporation and seepage is, together at different heights of water in his reservoir. This study may show him that the loss is greater the deeper the water in the reservoir. This indicates that seepage is the chief source of loss and would mean that the depth of water in that reservoir cannot be greatly increased. If, on the other hand, the loss during a dry week is not appreciably greater with a high head than with a low one, it indicates that the seepage is not large and that it would be possible to increase the depth of water by raising the height of the dam. In all

such measurements, of course, account can be taken of the overflow from different portions of the reservoir.

With regard to the loss of water caused by vegetation, on the reservoir, it may be stated that from what is known of the amount of water required for the growth of grass, it is very probable that considerably more water is lost when the reservoirs are covered with a dense vegetation than where only the free water is exposed. It will, however, probably be impossible to keep the shallow reservoirs on the peat moor regions free from vegetation, even if it were desired. The waves which would develop if only water were exposed would make it difficult to protect the dams.

There is one difficulty that is met with, however, in drawing the water from a reservoir of shallow depth and containing a heavy growth of moss and other vegetation, namely that the water cannot be drawn off rapidly for flooding purposes. This difficulty can only be overcome by cutting away the moss and peat for some distance back from the dam, so as to leave a free body of water which is immediately available and which will be renewed by the seepage from the upper part which is filled with vegetation.

Location of Reservoir.—With regard to the location of the reservoir, it is evident that the site should be such as to leave as large an area above it for the collection of water as possible and yet have the water in the reservoir at such a height as to make it available over the ground to be planted. In laying the main dam it is, of course, important that it run exactly at right angles to the line of fall of the land. This, as well as, the selection of the site itself will require careful levelling where the region is one of little fall, as is the case with most of the cranberry regions of the state.

Too much emphasis cannot be placed on the necessity for the use of the level in all work pertaining to irrigation and drainage, in general, and especially in connection with cranberry growing. There have been many instances in the development of the cranberry industry of the state where serious mistakes have been made in the location of reservoir sites and in the

direction which the dams have been given by a failure to make a careful survey with the level previous to construction.

The material out of which the dam is constructed must, of course, depend on what is available in each instance. The dams of most reservoirs on moors are, of course, constructed out of peat itself, and, indeed, one of the great advantages which a moor region has for cranberry growing comes from the fact that this peat is admirably adapted both for the construction of reservoir dams and for the small dykes or dams surrounding the planted plots. Owing to the fibrous nature of the peat it does not wash badly and retains its form well, as is seen in Fig. 45. It is, however, rather light, especially when it dries out, so that it is ordinarily desirable to cover it with from six inches to a foot of sand, in order to keep it from drying too much as well as to give it additional weight. It can then be used as a road, as shown in Fig. 46. The sand covering should extend down the inner face of the dam, so as to compress the light peat and thus lessen the seepage as well as to protect the peat of the dam. The depth to which the peat is cut or scalped for the construction of dams will depend on the thickness of the peat on the marsh. It is, of course, cheaper to scalp deeply for the construction of the dam, so as to lessen the distance of hauling, but care should be exercised that the depth be not so great as to weaken the bottom of the reservoir and increase the loss by seepage.

SIZE OF FLOODING DITCHES AND LOCATION OF RESERVOIR WITH REFERENCE TO PLANTED GROUND.

It is extremely important that the reservoir be near enough the planted ground and the ditches large enough to make it possible to flood the vines in a very short time. Almost every year there are two or three occasions when the temperature falls so rapidly that it is impossible to know more than two or three hours before, whether or not frost will occur. Provision must therefore be made to flood the ground in at least two hours in order to entirely protect from frost. In many instances a large portion or all of the crop has been lost by reason of the fact that the ditches used for flooding were too small and the

reservoir too far away from the planted ground to get the water on with sufficient quickness.

On account of the inclination of the land it is necessary to plant the cranberries in strips or plots separated from each other by low embankments or dams, which are used for holding the water, so as not to require more than a few inches at the deepest part. It is desirable that these strips be quite narrow in order to lessen the amount of water necessary, and they should be layed out with the long direction parallel to the main dam of the reservoir, that is at right angles to the line of cross flow. The lateral flooding ditches will then be close enough together, so that the water can be brought to the ground quickly and the distance between the ditch and the center of the plot will be so small that the water can spread over the entire plot in a short time. This arrangement of the plots in a narrow system is desirable, also, since it lessens the distance the sod scalpings must be carried in clearing the ground.

Drainage.—It is a matter of the utmost importance that adequate provision be made for thorough drainage of land planted to cranberries. This is necessary, first to remove the water applied for protection from frost, second that which comes as rain, third that which seeps up from the sand underneath. The influence of the relative dryness of the bog on the growth of the cranberries and on the formation of frost is a matter requiring careful study. We have planned and carried through the present season an experiment in which three plots are maintained at different degrees of wetness. On the first the water in the side ditches is held at a depth of 18 in. below the surface of the ground, in the second at a depth of 6 in., in the third at the level of the ground itself. The yields of these plots have not, at the present writing, been determined, although the indications are that the condition of the second is more favorable than either of the extremes. The degree of moisture, also, effects very greatly the growth of noxious vegetation, further mention of which will be made later. For all of these reasons, therefore it is desirable that the drainage ditches be such as to allow the reduction of the ground water level to a depth of 18 inches to two feet below the surface of the marsh proper. It is also im-

portant that the drainage ditches be large enough to withdraw the water at about the same rate that it is let on during flooding, that is it should withdraw three inches of water within two or three hours when necessary.

FORMATION OF FROST AND PROTECTION THEREFROM.

Frost is by all means the greatest enemy of the cranberry grower. It comes so irregularly and unexpectedly and is so destructive in its effects, that only the utmost vigilance and through control of the means of protection can make one secure from its attacks. At no time throughout the growing season apparently, can we consider ourselves free from the danger from this source. In the middle of June, 1903, a severe frost throughout the cranberry region reduced the yield by at least twenty-five per cent. Again the present year a frost early in August ruined the crop to an extent estimated at sixty per cent. Experiences of this kind, show how imperative it is that the cranberry grower provide thoroughly for protection from frost. While it is true that the frosts usually come with cyclonic storms that pass over our country at frequent intervals and hence are capable to some extent of prediction, the experience on the moor land of the cranberry region indicates that this prediction cannot at present be made with sufficient accuracy to be of much service to the cranberry grower. With temperatures of forty to forty-five degrees on surrounding higher land killing frosts have occurred on the cranberry marshes while at other times of low temperature the minimums are nearly equal.

The formation of frosts on the marsh areas has usuallly been supposed to be due to the settling of colder air from the surrounding higher land onto the marshes. Our observations the past season together with the consideration of the extent of the marsh land of this region indicates that this process is one of relatively small importance and that the formation of frost is very largely dependent upon the temperature of the ground and on the radiation of heat from it as produced by the condition of the atmosphere. Without discussing this in detail here, it may be said that the influence of the condition of the marsh itself, with

reference to the drainage, whether or not it has been sanded, and to the depth and thickness of the vegetation, especially of moss, seems to be the all controlling factor in the formation of frost or of at least its effect on the cranberries.

On the night of August 7th this year with a general minimum temperature over the marsh of twenty-five degrees small plots of ground which were well drained and sanded were entirely unaffected by the frost, while the berries on adjacent plots which were in a more moist condition and unsanded were entirely destroyed. This matter will be discussed fully in the bulletin above mentioned.

WEEDS AND METHODS OF DEALING WITH THEM.

All plants native to the cranberry bogs may be considered as weeds from the cranberry grower's point of view, and must be dealt with as such. These plants belong mostly to the lower order of vegetation, and include the Mosses, Ferns, Carexes, Grasses, Willows and others. All of them are not equally noxious.

The following partial list gives a good idea of the character and extent of bog plants which may be classed as weeds:—

Agrostis alba, L. Red top, Florin, Herd grass.
Agrostis hyemalis, Walt. Rough hair grass.
Bidens trichosperma, Michx. Fall tick-seed sunflower.
Calamagrostis Canadensis, Michx. Blue joint-grass.
Carex oliogosperma, Michx. Few seeded sedge, wire grass.
Cicuta bulbifera, Br. and Br. Bulb bearing water hemlock.
Dulichium arundinaceum, L. Dulichium.
Eleocharis monticola, L. Spike Rush.
Eriophorum Virginicum, L. Virginia cotton grass.
Homalocenchrus oryzoides, L. Rice cut grass.
Juncus Canadensis, J. Gay. Canada rush.
Juncus acuminatus, Michx. Sharp fruited rush.
Panicularia Canadensis, Michx. Rattlesnake grass.
Poa fláva, L. False red top, Fowl meadow grass.
Rynchospora alba, Vahl. White-beaked rush.
Scirpus lineàtus, Michx. Reddish-bulrush.

Scirpus polyphyllus, Michx. Leafy-bulrush, bunch grass.

Xyris flexuosa, Muhl. Slender yellow eyed grass.

Salix myrtilloides and *Salix myrtilloides.* Var. *Pedicellaris,* L. Bog willows.

Spiraea tomentosa, L. Hardhock.

Andromeda Polifolia, L. Sage brush, Moorwort, Wild rosemary.

Chamadophne calyciluta, L. Leather-leaf, Feather leaf.

Spagnum spec., L.

Bryacea spec., L. Wood Moss.

These plants are not equally noxious and difficult to eradicate. The bog willows are very noxious on bogs which have not been scalped, though scalped bogs are not exempt from the plants. Since they spread very rapidly by seeds care should be taken to keep the surrounding bog land free from willows either by complete eradication or by annually cutting of the plants to prevent them flowering. If seedlings appear in the cultivated bog they should be pulled up as soon as they are discovered. If permitted to grow for a season or two it is almost impossible to get out all the roots. The swamp spiraea or hardhock is not difficult to combat. It does not spread much by its roots and can easily be pulled up.

The same is true of the Andromeda calycelata or Feather leaf. The sedges and grasses are more difficult to combat since many of them have creeping rootstocks which ramify through the peat in all directions. The bunch grass (*Seirpus pollyphyllus*) is perhaps most dreaded of bog weeds, see Fig. 47. It is a perennial with spreading roots which take firm hold of the bog. It grows in dense tufts and produces an abundance of seed. The methods of combating grasses, sedges and carexes must vary with the condition of the bog. If scalping and sanding were universally done the weed question would be an easy one, since in scalping the crown and the principle roots are taken off. If in addition to this the bog is sanded very few of the original plants would reappear.

One of the most common weeds in the cranberry bog is Carex oliogosperma, commonly known as wire grass. It is a

FIG. 47.—Bunch grass (*Scirpus pollyphyllus* Michx). One of the worst cranberry weeds in Wisconsin. Original, greatly reduced.

common belief with many cranberry growers that this plant is beneficial to the young cranberry plants, since it shades the plant and the berries from the hot sun. This may be true to the extent of shading, but it should be borne in mind that this grass uses a great amount of plant food which is taken away from the cranberry vines and is just as detrimental as any of the weeds. It is also argued by many that the presence of sedges and grasses on the marsh have a tendency to protect the berries and vines from being injured by frost. The relation of frost to vegetation will be fully discussed in a bulletin. In general, it should be stated that all vegetation, outside of the cranberry vines, found on the bog or marsh is detrimental to the production of a large yield. At this point the writer cannot forego the temptation of calling all cranberry growers' attention to the prevailing condition in Wisconsin. At the present writing there are few cranberry bogs in the state that are entirely free from weeds. This is due to the desire of the marsh owners to put as large an area as possible into vines, without proper preparation. Cranberry growing in Wisconsin at the present is in the same condition as wheat growing in the Red River Valley was fifteen or twenty years ago. The main desire seems to be to get large areas in vines without proper preparation of the bogs. The result has been that we have an immense acreage devoted to cranberry growing, yielding a comparatively small number of barrels to the acre. If cranberry growing is to be successful and profitable, this method must be abandoned and smaller areas properly prepared and taken care of substituted. In other words, cranberry growing must become intensive instead of extensive, as it is at the present.

There are several ways of destroying the Spagnum moss, and wood moss. Experiments have proven that a small application of common salt or salts in the commercial fertilizers will do much to eradicate the weeds. The amount of salt to be used must be determined by the season. If the season is wet, a considerable amount of salt should be used; if, on the other hand, the season be dry, a smaller amount of salt should be applied, as otherwise the cranberry vines would be injured by it. The use of lime in destroying the Spagnum moss has been practiced

with good success on the Bennett marsh near Cranmoor the past season. Perhaps the most rational way of combating the mosses is by drainage. If the drainage is perfect, as it should be, there is very little danger from the mosses, as it will not live and thrive on the bog that is drained. Sudden flooding and taking off of the water is very injurious to these plants.

DISEASES.

Among the most prevalent fungus diseases infesting cranberries is what is commonly styled the cranberry scald. It belongs to a class of fungi known as Rosellinia; the specific name has not been given. The amount of damage caused by this disease varies greatly with the season. In some years, as much as 75% of the crop has been destroyed. The disease is more prevalent in the East than it is in Wisconsin, although last year considerable damage was caused to the fruit after the berries were picked. The first sign of disease in the berry is a soft spot that appears on one side. The whole berry soon becomes soft and infested and takes on the appearance of being scalded or cooked. The whole texture of the interior is changed into a soft watery mass. The berries are at first dirty-white in color, but soon change into a light brown. The disease was studied at the Station during the last winter in the artificial culture media, with good results. It is impossible to say from the appearance of a berry whether it is infested or not, since a berry, to all appearance healthy, may be infested. There is a great difference in the appearance of the fungus when grown under Wisconsin conditions from that grown under eastern conditions. The berries in the east do not change to the brown color like they do in Wisconsin. This has been proven to be due to the difference in the climate and soil conditions. We find that berries grown in the east and inoculated with this disease produce the characteristic color of the eastern berries, while the Wisconsin berries retain the Wisconsin color. How the fungus attacked the fruit is difficult to determine from laboratory experiments. This must be determined under actual field conditions. At present, the writer is inclined to

believe that the fungus enters the vines and lives perennially in the vines, from which it enters the berries. If this is the case, the method of combating the disease is a difficult one. The best solution, at the present, to this question would, perhaps lie in the manner of storing the berries after picking. The development and progress of the disease is greatly increased if the berries are kept at a relatively high temperature after picking. This is due to the fact that in order for the fungus to develop is must have a certain temperature. If the berries are kept below this temperature the disease does not develop or spread. Moisture is also an important condition for the development of the disease. We found that the diseased berries sprinkled with water and placed in a vessel became infested with disease and were destroyed within a few days, while perfectly normal berries, not infested, remained normal. Berries kept in dry conditions at normal temperature arrested the progress of the disease and the infested spots became shrunken and dry. When the life history is known some remedy may be found that will place the disease under control, but until the true nature and life history of the fungus is known, the cranberry growers should endeavor to store their berries in as dry a state as possible and to keep the temperature low.

Experiments in progress to test the efficiency of Bordeaux Mixture as a fungicide, especially against what is termed blossom blight were conducted as follows: First application was made just before the blossoming; the second, just after the blossom had fallen, and again two weeks later. The result of this experiment showed a gain of 30 bushels per acre over those not sprayed. The experiment will be repeated on a larger scale next year. The bulletin by Professor Goff, on Diseases and Insects Peculiar to Cranberry Cultures, should be read in this connection.

VARIETIES.

When the Agricultural Experiment Station took charge of the Cranberry Station, there were upwards of two hundred so-called varieties of cranberries growing on the station plots. These had been collected from all parts of the globe and planted

in a nursery for study and comparison. Botanically speaking, there are only two species of cranberries found in the wild state —the European species Vaccinium oxyzoccus (Gray), (Oxyzoccus oxyzoccus, Brown & Brit); and the American species, Vaccinium macrocarpus (Gray), (Oxyzoccus macrocarpus, Brown & Brit). These are the only two species known of the wild cranberries. The fruit, however, is quite variable when grown under different conditions. Hence it is that we find large and small berries, differently colored, and maturing at different seasons, when taken from different sections of the country. So far as we know at present there are no hybrids between these two species.

Almost all of the cranberry varieties now in cultivation belong to the American wild species. Out of the large number of varieties grown on the Station grounds, there are but few that are worthy of further consideration. These are being carefully watched and studied, with the idea of introducing them after they have been thoroughly tested and tried.

In the growing of cranberries, it should not be forgotten that the size and color, as well as the season of ripening, is greatly influenced by the condition of the marsh and the state of fertility of the marsh. Experimenters have found that in the testing of varieties, the result obtained is far better than would be obtained under field culture, since invariably sample varieties are taken better care of and given better conditions, than those under ordinary field culture, and what often promises to be a desirable variety when grown in the nursery, turns out to be a worthless one under ordinary field conditions. At the present, the varieties of cranberries are considerably mixed, and it is to be doubted whether we have at the present a single pure variety.

HARVESTING AND KEEPING.

The methods of harvesting in practice in Wisconsin are those of raking with long rakes and picking by hand; the method used depending mainly upon the conditions of the marsh and the conditions of the season. The comparative cost is considerable. Hand picking is easier on the vines if the hand

pickers are careful in handling them; but it is not nearly so rapid as raking. The price paid hand pickers for picking, is usually 50 cents per bushel. Rakers are usually paid from $1.50 to $2.00 per day and board and one raker can gather several times the amount of berries in a day that one hand picker can; the loss in this case being not only in the injury to the vines by breaking them and tearing them loose, but by the loss of berries shaken from the vines in pulling up long runners.

The time of harvesting is, at the present, regulated not only by the maturity of the fruit but also by the condition of the weather. If the season is backward, the berries are picked before they are ripe. In such cases, the keeping qualities of the fruit are endangered. The same is true if the berries are over-ripe when picked. There is a happy medium between these two extremes that should be followed. Last year, records were kept of the keeping qualities of a number of samples of berries; the observations being taken in January and April. From this record, it was shown that nearly all varieties picked on the first day of September were in much better condition than those picked September 25th.

But, if the picking is done too early, the berries, as a rule, have not attained their full size and will not be as large as if the berries were permitted to grow for one or two weeks longer. This was illustrated by the experiment which was carried on this fall. Two pickings were made of one hundred and ninety varieties at the Station. It was found that during the interval between September the 7th and the 24th, the dates of the two pickings, the loss from the early picking was over 5%, showing conclusively that the berries had not attained their full size, and that an increase of 10% was realized by deferring the picking until September 24th, when the berries had attained their full growth.

While this is true, so far as experiment goes, it should be borne in mind that other conditions beside the ripeness of the fruit must be taken into consideration in determining the keeping qualities. The weather conditions, before and during the time of picking and subsequently, greatly influence the keeping qualities, and the reverse of the above result would be quite possible if the conditions were unfavorable.

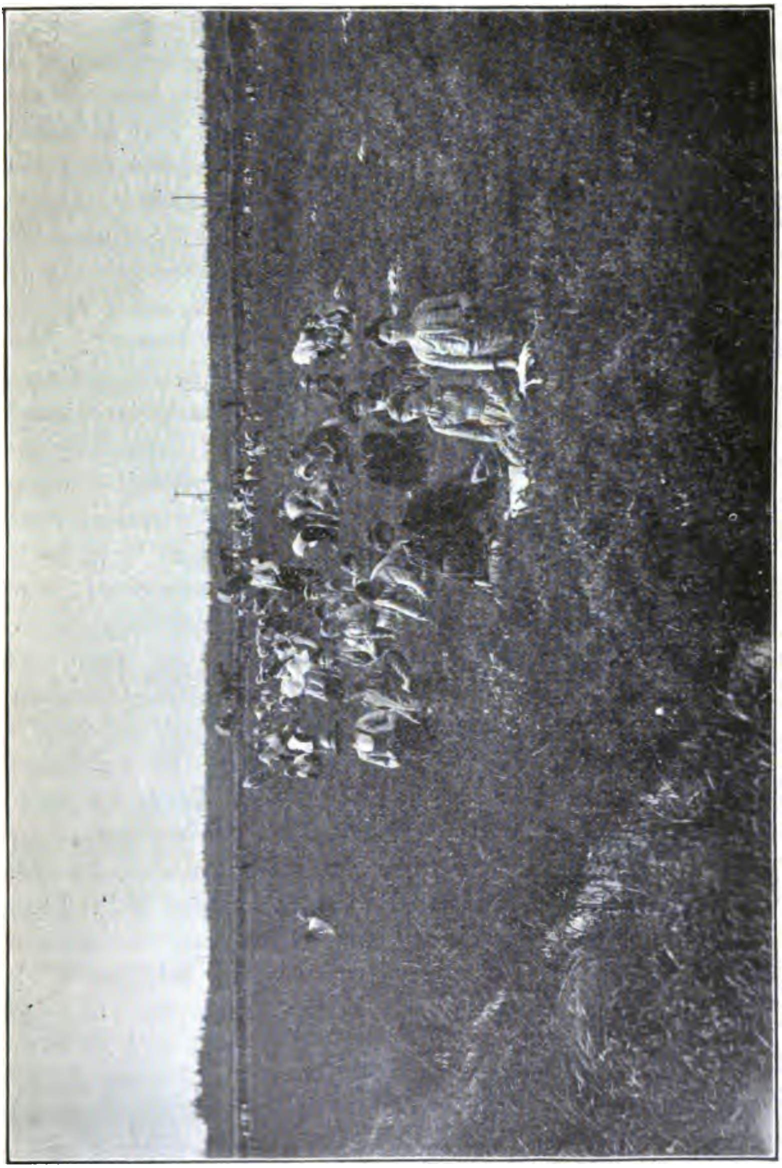


FIG. 48.—Picking cranberries, Wood county. Original.

The conditions under which cranberries are harvested apparently have much to do with the keeping qualities. The experience of most of the cranberry men in this state during the season of 1903, goes to show that cranberries, harvested in wet conditions did not keep well. This was, however, not due so much to the conditions under which they were harvested as to the fact that most of the berries were stored in a wet condition, with the chaff, moss, and grasses which were gathered with them. Then, too, the method used in milling the cranberries is at fault, and often greatly injures the keeping quality. When the berries are run over the so-called "jumpers," they strike the box or barrel below and become dented. It is at these dents that the decay first sets in. If ordinary fruits were handled in this manner, they would be rejected by commission merchants, and it is to the advantage of cranberry growers to remedy this defective method of cleaning and sorting the berries. The condition of storage during the drying and sorting process might be overcome by properly constructed store-houses through which the air could circulate freely and forcibly. It may even be necessary to use artificial drying. The popular belief that the cranberries must be kept in the chaff and moss with which they are gathered, in order to color up, is wrong. The sooner the fruit is separated from the debris, the better it is for the fruit, since many fungus diseases are present in this debris. Besides, the berries would color up as well without the debris as with it.

Cold storage in the keeping of cranberries has up to the present received little attention. Mr. Tuttle shipped to St. Louis last fall a barrel of cranberries and placed same in cold storage, where it was taken out in August, this year. It has been reported that the berries came out in first class condition. The effect of a change from cold to warm temperature was shown in cranberries shipped from Minneapolis, last winter, where they were kept in cold storage for several weeks. When taken and placed in a warm temperature, the condensation of moisture was very great, and this induced a decay of the fruit within a few days.

The method of laying out, preparing and sanding cranberry bogs will be fully described in a bulletin.

TOBACCO INVESTIGATIONS—PRELIMINARY REPORT

E. P. SANDSTEN.

CHAPTER 344, LAWS OF 1903.

An Act making additional appropriations to the regents of the university of Wisconsin for current expenditure and various university needs and for investigation.

Section 4. Appropriations for cranberry and tobacco culture and investigations for State Board of Health. There is hereby appropriated annually for the period of two years from the general fund of the state, out of any moneys not otherwise appropriated, the additional sum of five thousand and five hundred dollars to the university fund income of the university of Wisconsin for uses and purposes as follows, to-wit: Twenty-five hundred dollars annually for two years for the investigations tending to the enlargement and improvement of the cranberry industry of the state, including the study of the shortage and supply of waters, suitability of marshes, the best methods of planting, flooding, draining and cultivating the berry and combating its diseases; fifteen hundred dollars annually for two years for the investigations in the growth and curing of tobacco; fifteen hundred dollars annually for two years for the establishment and maintenance of a hygienic laboratory in connection with existing bacteriological laboratories with proper and necessary apparatus for the chemical and bacteriological examination of water supplies and of the cases of infectious and contagious diseases peculiar to man and animals, and the use of which laboratory, so far as necessary and as arranged satisfactorily to the regents, shall be given to the State Board of Health.

Duty of Secretary of State. Section 5. The Secretary of State is hereby authorized and directed to include in the appropriate tax levies the sums ordered levied and collected by this act.

Section 6. This act shall take effect and be in force from and after its publication.

Approved May 20, 1903.

Wisconsin is one of the leading tobacco growing states in the Union. The total value of the crop is estimated at over $3,-000,000 annually. This important agricultural industry has developed slowly but steadily for the last fifty years, without any aid from the state. At the last session of the State Legislature a bill was introduced providing for an annual appropriation of $5,000 to be expended under the direction of the Agricultural Experiment Station of the State University. The

FIG. 49.—Showing a typical Rock county tobacco field. Farm of E. M. Calkins, Janesville, Wis. (Original.)

amount was cut down to $3,000 for two years. The bill so modified was passed at the urgent solicitation of the tobacco growers and leaf dealers. The line of investigation was left to the Agricultural Experiment Station.

After numerous inquiries and consultations the following line of work was outlined: First, the improvement of the Wisconsin tobacco seed so as to improve the quality, increase the yield and early maturity of the tobacco.

A brief survey of the tobacco growing sections revealed the fact that all kinds and types of tobacco leaves were grown, and that the tobacco dealers have found this state of affairs greatly injurious to their business. The growers too have been obliged to take a much lower price for mixed and uneven lots of tobacco.

After looking about for some time for a variety that would nearest fulfill the requirements for a typical Wisconsin tobacco, and after consulting with several of the leading tobacco dealers, a strain of Connecticut Havana seed leaf, Wisconsin grown, was selected. One acre was planted to this tobacco for seed on the farm of Mr. A. L. Fisher in Rock county. The field was isolated from other fields of tobacco. Just before blooming time the field was carefully gone over and more than one half of the plants were destroyed, leaving only those plants presenting the highest type to mature seed. About seventy pounds of tobacco seed were grown in this way. Almost all of this seed was distributed to the tobacco growers in various sections of the state for trial, free of charge. The report from the seed has been very gratifying and the expectations entertained fully realized. At the beginning of the present season two acres were planted with tobacco plants from the selected seed, one acre in Rock county and one in Crawford county. These two acres have just been harvested and the result of last year's careful selecting and "rogueing" is very marked. The stand was very even and the plants were typical in all respects. The seed from these two acres will be distributed among the tobacco growers the coming season.

Second, Fertilizer Experiments. It is a well known fact that tobacco is a heavy feeder and requires a fertile soil to produce a good yield. As a result, the tobacco growers have been obliged

to apply large quantities of barnyard manure to the tobacco fields often at the expense of the other farm crops.

This method of farming is not profitable in the long run, and soon some step must be taken to remedy this practice. To aid in the solution of this question a series of fertilizer experiments were inaugurated. Due to the lateness in passing the bill, May 20th, 1903, the fertilizer experiments were confined to Rock and Columbia counties for that year. In Rock county the fertilizer experiments were carried on on the farm of Mr. E. M. Calkins near Janesville. Six one-acre plats were arranged as per table No. I.

Fertilizer Table No. I.

Tobacco field of E. M. Calkins, Janesville, Wisconsin.

	Amount of fertilizer applied.	No of applications.	Yield of leaf.
Plat No. 1	250 lbs. sulfate of potash	2	1,106 lbs.
Plat No 2	200 lbs. nitrate of soda	2	1,224 lbs.
Plat No. 3	10 tons barnyard manure (estimated)	1	1,120 lbs.
Plat No. 4	150 lbs. nitrate of soda, 150 lbs sulfate of potash. 150 lbs. of acid bone	2	1,440 lbs.
Plat No 5	150 lbs. nitrate of soda, 150 lbs sulfate of potash	2	1,319 lbs.
Plat No 6	250 lbs acid bone	2	1,350 lbs.

From the above table it will be seen that the gain in pounds of leaves from plat No. 4 over plat No. 3 which was fertilized with barnyard manure was 320 pounds—28.5%. There was a smaller gain in the yields of plats two, five and six. There was a slight loss from plat one as compared with plat three. It should be stated that the land had previously been very heavily fertilized with barnyard manure for a number of years and for this reason no striking difference was expected. Then too, the weather conditions during the season of 1903 were not favorable to the best growth of tobacco, and the fall and early winter were cold and dry, preventing the crop from curing properly.

In Columbia county the fertilizer experiments were located on the farm of Mr. Gunder Uuderdahl, eight miles west of Rio. Six one-acre plats were used. The arrangements of the plats

and the kinds and amounts of fertilizers used are given in the fertilizer table No. II.

Fertilizer Table No. II.

Tobacco field of Gunder Underdahl, Rio, Wisconsin.

	Amount of fertilizer applied.	No. of applications.	Yield of leaves.
Plat No. I	200 lbs. of dried blood	2	1,431 lbs.
Plat No. II	250 lbs. of sulfate of potash	2	1,284 lbs.
Plat No. III	250 lbs. of accidulated bones	2	1,110 lbs.
Plat No. IV	100 lbs. dried blood 100 lbs. sulfate of potash 100 lbs. accidulated bone	2	1,201 lbs.
Plat No. V	150 lbs. dried blood 150 lbs. sulfate of potash	2	1,194 lbs.
Plat No. VI	10 loads of barnyard manure	1	994 lbs.

The result as shown in Table No. II is perhaps more striking than the result at Janesville, Rock county. Every plat manured with commercial fertilizers showed a distinct gain over the plat fertilized with barnyard manure. The greatest increase being from plat No. I where there was a difference of 437 lbs., or nearly 46%.

Too great reliance should not be placed upon these results, since fertilizer experiments of this nature should be carried on for a series of years. Seasonal variations, such as rainfall, distribution of rainfall and temperature greatly influence the growth of the plant as well as the efficiency of the fertilizers. The season of 1903 was not favorable to the best development of tobacco, and this, of course, greatly affected the quality as well as the yield.

The results of these experiments, while not conclusive, point to some benefit to be derived from the use of commercial fertilizers. They have also brought out the peculiarities of soils in different sections of the state and the lack of these soils in one or more essential fertilizer elements. The result obtained at Rio in Columbia county shows conclusively that great benefit is to be derived from the use of nitrogenous fertilizers; the difference in yield between plats No. 6 and No. 1 being 437 pounds.

But this should not be taken as an indication that all soils are lacking in nitrogen. Each county and each section of the county must be studied separately, and the requirements of each soil be determined before the need of the soil can be accurately gauged. The Experiment Station can do much to assist the tobacco growers in the various counties by studying the peculiar requirements for each section, so that the farmer may be guided in the use of commercial fertilizers. During the present year fertilizer experiments are being carried on in Rock, Columbia, Crawford, Vernon and Eau Claire counties. The results of these experiments cannot be told until the tobacco is cured and weighed. In Rock and Columbia counties acre-plats are used for these fertilizer experiments as in the past year, while in Crawford, Vernon, and Eau Claire counties half-acre plats are used for each kind and combination of fertilizers.

Cover Crops.—In planning tobacco experiments, it occurred to the writer that cover crops might be used as a means of maintaining the fertility of the tobacco lands. With this end in view, cover crop experiments have been started at each place where fertilizer experiments are being carried on. The crop used for this purpose was hairy vetch. The plant belongs to the legume family and is perfectly hardy. It was sown the last week in July, when the tobacco was cultivated for the last time. At the present writing, the vetch is looking promising and completely covers the soil where the tobacco stood. The plant keeps on growing until stopped by a heavy frost, remains green during the entire winter and starts to grow again early in the spring; forming a dense mat of green herbage, which can be plowed under in time to use the land for another crop of tobacco. Not only does this plant furnish protection for the soil during the winter and yield a large amount of vegetable matter, thus improving the physical condition of the soil; but it also contains a large amount of nitrogen which the plant takes from the air in the unavailable form and makes it available for plants to use, thus being a soil improver and fertilizer at the same time. If this experiment should prove a success, it will be a means by which the tobacco grower can supply a large portion of nitrogen that is needed by this crop, in a very inexpensive way.

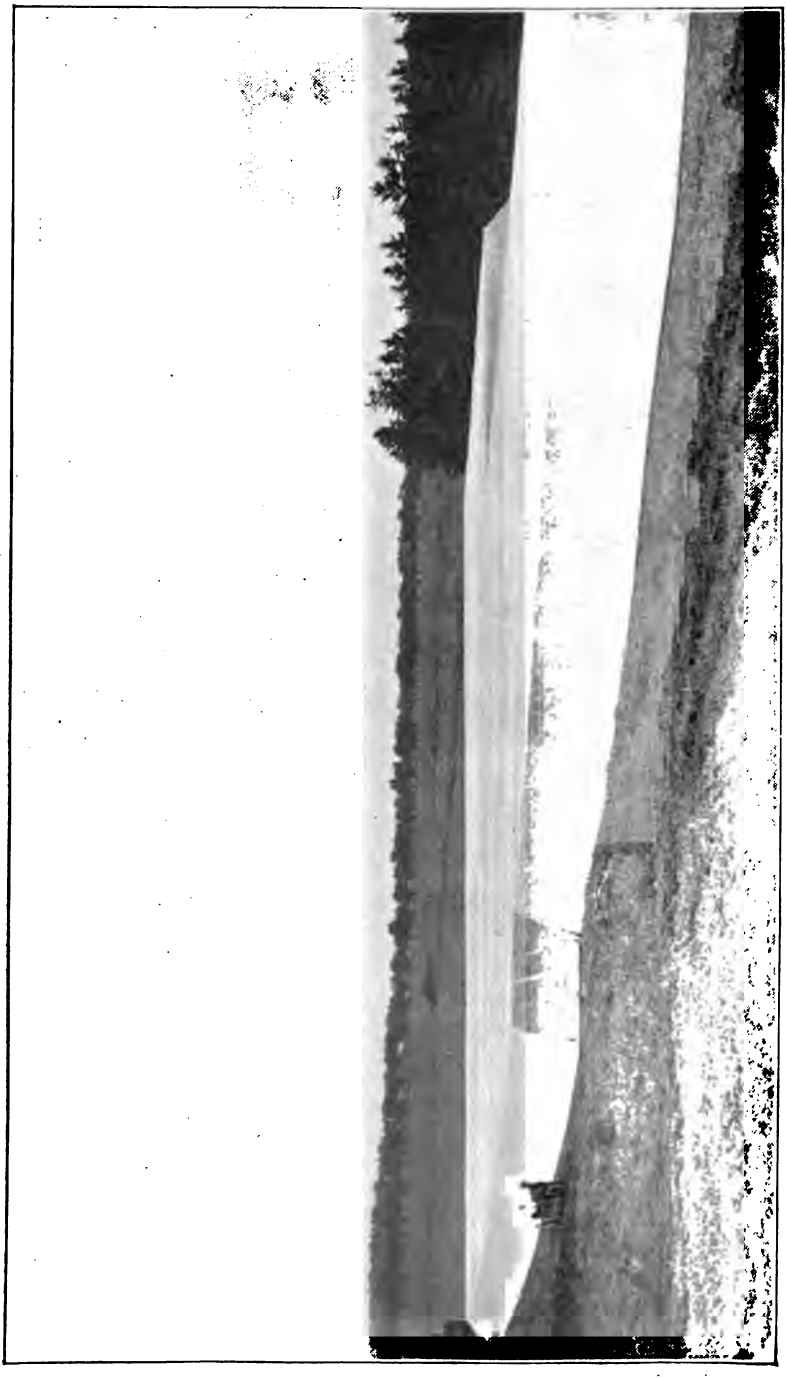


FIG. 50.—View of Sumatra tobacco tent where part of Sumatra tobacco experiments were carried on. Property of S. B. Heddles, Janesville, Wis. (Original.)

FIG. 51.—Interior view of Sumatra tobacco tent. (Original.)

Experiments to test the effect of different commercial fertilizers upon the burning quality of tobacco were inaugurated this year. It is too early to report on the results of these experiments, since tobacco is not sufficiently cured to test its burning quality.

GROWING SUMATRA TOBACCO UNDER COVER.

In order to ascertain the adaptability of Wisconsin soils and climate for the production of shade grown Sumatra tobacco, arrangements were made the past year with Mr. S. B. Heddles at Janesville, Wis., to carry on experiments on his plantation of shade-grown Sumatra. The results of these experiments, while promising in so far as the production of the leaf of the tobacco goes, did not yield conclusive results. The unsettled condition of the shade-grown Sumatra tobacco market, and the failure of the Connecticut growers to dispose of their crops profitably, made the question of advisability for the Experiment Station to further investigate the subject, problematic. After visiting the various tobacco growing sections of the state, and after inspecting two small plantations of shade-grown Sumatra at Sauk City, Sauk county, it was thought advisable to continue the investigation with the Sumatra for another year, in a different locality where the soil would be more favorable for the growth and development of the plant. A small plantation, of a sixth of an acre was finally secured on the farm of John Hoverson, near Soldiers' Grove, in Crawford county. The chief objection to the shade-grown Sumatra at Janesville, and the Connecticut shade-grown Sumatra, is the brittleness and the lack of texture of the leaf. This objection, it was thought, in the main could be remedied if the proper soil conditions could be found. At the present writing the shade-grown Sumatra has been harvested with very satisfactory results. However, no report can be given of the ultimate result until the leaves are cured and fermented. A full report will be given in a bulletin.

COVER CROPS,

E. P. SANDSTEN.

Most of the Wisconsin orchards are kept in sod. This practice, while partially successful in times past, is gradually being superseded by clean culture, when the lay of the land permits, and the use of cover crops. On new land and in a new country, sod orchards have proven profitable for a number of years. This is due to the fact that such soil is naturally very fertile and can well support the growth and fruitage of an apple orchard for a number of years, but we know of no soil that is inexhaustable, and sooner or later the sod orchards become unproductive and fertilizers must be applied in order to make them fruitful and profitable.

Apart from the value of cover crops as fertilizers and general soil improvers, there is another benefit derived from them which must not be overlooked by Wisconsin orchardists. Our severe climate with long, cold and dry winters, is very hard on the fruit trees, and numerous complaints are made that the trees either become greatly weakened or die from the exposure to these inclement conditions. It is a well known fact that all trees evaporate a considerable amount of water during the winter, and when the soil becomes frozen to a depth, below that at which the roots of the fruit trees penetrate and remain in this frozen condition for nearly the whole winter, there is little chance for the roots to supply the water lost by the trunk and branches by evaporation during the winter. Careful observations have revealed the fact that in many instances the bark of many varieties have become shriveled and dry as a result of this evaporation.

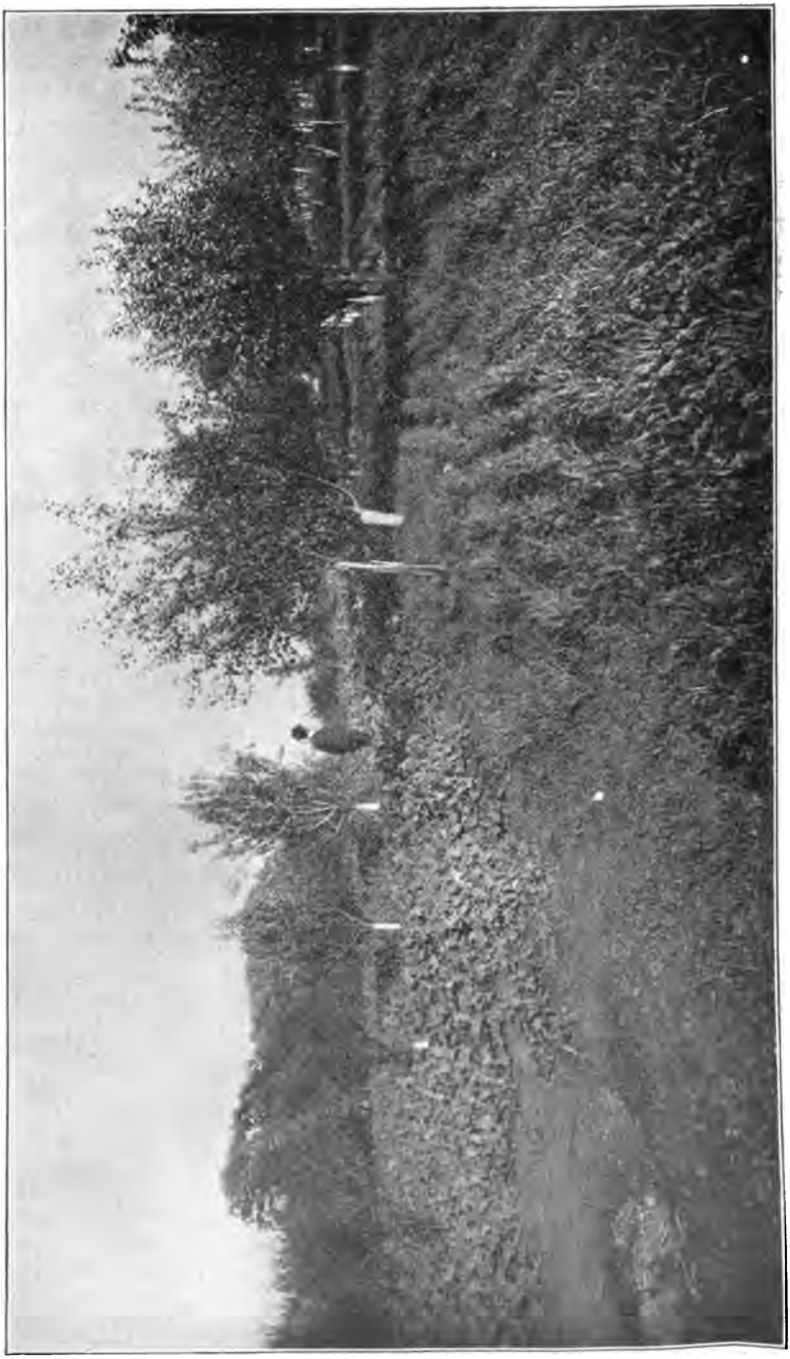


FIG. 32.—Cover crops of oats and rape in the Experiment Station orchard. (Original.)

It might be argued that an orchard in the sod would fare better, as regards soil protection, than an orchard in clean culture, but this is not always the case. An orchard in sod suffers more quickly from drought than one under clean culture. The grass grown in the sod orchard uses large quantities of water for evaporation and this is taken from the soil, thus robbing the roots of the trees of the much needed moisture during the latter part of the summer and fall, when the trees should store up moisture for the winter. Then, too, ordinary grass sod does not offer the resistance to cold as do cover crops. This is due to the fact that the grass sod is more compact in texture than the cover crops and permits the cold to penetrate to greater depth.

In order to determine the relative protective value of oats, rape, hairy vetch, and blue grass sod, as protections against the cold, measures were taken to ascertain how deeply the frost had penetrated the soil under the four mentioned cover crops. The accompanying table gives the results.

Table III.

Plants used for cover crops	No. of inches frost penetrated
In orchard under clean culture and the soil left unprotected during the winter	16 inches.
Under cover crop of oats	8 inches
Under cover crop of hairy vetch	7½ inches.
Under cover crop of rape	15 inches.
Under cover crop of blue grass sod	18 inches.

The measurements were taken February 3d. The result of this experiment is highly interesting. It was a surprise to the writer that the oats gave such excellent protection to the soil, while the blue grass gave a negative result. The hairy vetch which proved to furnish the best protection should be looked upon as one of our most valuable plants for cover crop. The rape plant does not furnish any protection to the soil, to speak of, and its chief value would lie in the fact that it furnishes some fertilizer materials to the soil, and it, also, has been reported that rape and many other of the cruciferae

plants are capable of making available insoluble phosphates in the soil. This, however, needs further investigation.

Cover crops are best adapted to orchards kept in clean culture during the spring and early summer. The cover crops should be sown from the first to the tenth of August, so that they may attain considerable growth and cover the soil before growth ceases in the fall. The following amounts should be used:

Hairy vetch from 50 to 60 lbs. per acre, cow peas $1\frac{1}{2}$ bu. per acre, rye and oats $2\frac{1}{2}$ bu. to the acre, rape 4 to 5 lbs. to the acre, using the Dwarf Essex variety.

The cover crops may be divided into two general classes: those that are capable of assimilating free nitrogen from the air by the aid of bacteria, and those which do not. Clovers of all kinds, hairy vetch, and cow peas belong to the first class. These are especially adapted to lands poor in nitrogen, or in orchards where the wood growth is weak and the trees have a sickly appearance. They are not well adapted to orchards which are in heavy wood growth as it tends to further stimulate this tendency at the expense of fruit production. The orchardist and farmer must judge for himself whether he should use oats, or hairy vetch, or cow peas for his orchard.

One great point in favor of the hairy vetch is, that it is perfectly hardy, grows close to the soil and covers it with a dense mass of green herbage which acts as a blanket for the soil. It remains green during the winter, starts to grow as soon as the frost is out of the ground in the spring, and when turned under in the spring, furnishes a large amount of valuable fertilizer. The rape, cow peas, oats and rye die with the approach of winter and the dead portions remain on the ground as protection, which in most cases is very small, though they serve to catch and hold the snow which is in itself a great protector. From observation and experiments, the writer recommends the use of the hairy vetch whenever possible, as it is undoubtedly the best all round plant for cover crop that we have. The great drawback at the present to the use of the hairy vetch is the cost of the seed, it being quoted from \$6.00 to \$7.00 per hundred pounds, which would make the

FIG. 53.—Cover crop of hairy vetch in the Experiment Station orchard. (Original.)

price of seed per acre from $3.00 to $3.50. The vetch produces seed quite freely in Wisconsin, and the orchardist can easily arrange to gather the small amount of seed needed for future crops.

Rye has been strongly recommended by many as a cover crop though it has one great drawback, that it is difficult to kill out in the spring; otherwise it would make a good crop, especially in a fertile orchard. In our experimental orchards, oats has given good satisfaction, and the writer would recommend it in preference to rye. Oats should be sown not later than August the tenth in order that it may grow to a considerable height before being killed out by the frost, otherwise it will not catch and hold the snow during the winter.

From the experiments with cover crops during the past two seasons, the writer firmly believes that a large share of the winter killing of fruit trees in the state can be prevented. Not only this, cover crops will greatly improve the soil conditions in the orchard and add considerable fertility to the soil.

EVAPORATION OF WATER FROM APPLE TREES DURING THE WINTERS OF 1902-3 AND 1903-4.

E. P. SANDSTEN.

In order to ascertain the amount of water an apple tree would evaporate during the winter, four eight-year old apple trees were sawed off close to the ground and placed in an upright position among the other trees in the orchard. The weight of the trees were taken immediately after they were cut off and again once a week throughout the winter. During the winter 1902–1903 four trees were used, and during the winter 1903–1904 two trees were used. The following tables show the rate of evaporation from the respective trees during their respective winters.

Table 1 V.

DATE.	WEIGHT OF TREES.			
	No. 1.	No. 2.	No. 3.	No. 4.
1902.	Lbs.	Lbs.	Lbs.	Lbs.
December 19	36.6	24.6	35.7	30.4
December 26	35.5	23.3	34.5	29.5
1903.				
January 2	36.0	24.	34.	30.
January 9	35.5	23.2	34.3	30.
January 10	35.5	23.8	35.	29.6
January 23	35.2	23.4	34.6	29.6
January 30	35.6	24.0	35.	30.
February 6	35.6	23.7	34.7	29.2
February 13	35.	23.3	34.2	29.
February 20	34.5	23.	33.8	28.7
February 27	34.7	23.5	34.4	29.
March 6	33.9	22.4	32.9	28.
March 13	33.6	22.7	33.4	28.0
March 20	33.2	22.6	33.	27.6
March 27	32.6	22.	32.4	27.4
April 3	31.4	21.4	31.6	26.5

Table V.

DATE.	WEIGHT OF TREES.	
	No. 1.	No. 2.
1903.	Lbs.	Lbs.
December 5	26.2	24.2
December 12	26.4	24.4
December 19	26.3	24.8
December 26	26.2	24.6
1904.		
January 2	26.4	24.4
January 9	26.4	24.4
January 16	26.2	24.2
January 23	26.	24.
January 30	26.	23.9
February 6	26.1	24.5
February 13	26.1	24.5
February 20	25.9	24.2
February 27	25.7	24.
March 5	25.8	24.2
March 12	26.	24.2
March 19	25.9	24.
March 26	25.6	23.6

At the close of the winter of 1902–1903, April 3d, the difference in weight was approximately five pounds per tree between the first and the last weighing, showing that the total amount of water that evaporated during the winter was from 15 to 20 per cent of the total weight of the trees. When we consider the size of the trees, this amount is quite considerable. The results for the winter of 1903–1904 are less striking. This was due to the fact that the winter, while quite severe, was often moist and with a large number of cloudy days, and undoubtedly, the trees took up considerable moisture from the atmosphere. The last weighing, April 16th, trees Nos. one and two had lost only a pound or about two per cent of the total weight of the tree, showing that the rate of evaporation is greatly influenced by the humidity of the atmosphere throughout the winter, as well as by the low temperature. It is a common belief among Wisconsin fruit growers that the low temperature is the chief cause of the winter killing of fruit trees in the state. This belief is not borne out by actual experience and observation. Low temperature is not necessarily fatal to fruit trees providing the rainfall and the humidity are sufficiently great. Then too, the condition of the trees and the amount of moisture in the soil in

the fall have much to do with the question. Last winter was favorable in this respect. The temperature throughout the winter was much lower than for a number of years past, but the fruit trees went into the winter rest in a well matured condition and the soil was full of moisture. Then too, we had few dry, windy days. As a result we have had no complaint of winter killing, except the peach, European and Japan plums, which are not considered hardy where the temperature reaches 35° to 40° below zero. Shrubs and ornamental trees suffered no noticeable damage from the severe winter.

FORCING BEANS.

C. A. VALLEJO.

All the common beans, Phaseolus vulgaries, of today, are now believed to be natives of tropical America where they were originally climbers and required a long season to mature their green pods. But through long and careful breeding and wise selection of the individuals best adapted to the varied conditions and uses of this most important farinaceous food, we have many varieties of green and wax beans and, what is more remarkable, the season for maturing is so much shortened that we can grow several crops even in our relatively short summers.

Although dwarf or bush beans have been cultivated under cover quite extensively by gardeners near the large cities, they are not considered a very profitable crop, perhaps because all the room must be given to beans alone, and also because of the apparent shyness of the yields. This cannot be explained but through a lack of knowledge of the best cultural methods and unwise selection of varieties, as beans are generally very productive.

People think that beans can grow and produce their best yields in almost any kind of soil, and this belief has led growers to neglect altogether the fertility and the physical conditions of the soil. While it is true that beans can get a great deal of nitrogen from the atmosphere through the aid of certain micro-organisms living in their roots, it should not be forgotten that they need just as much potash, phosphates and other mineral elements to live and do their best upon, as other vegetables, and that they have to draw their supply of these constituents from the soil.

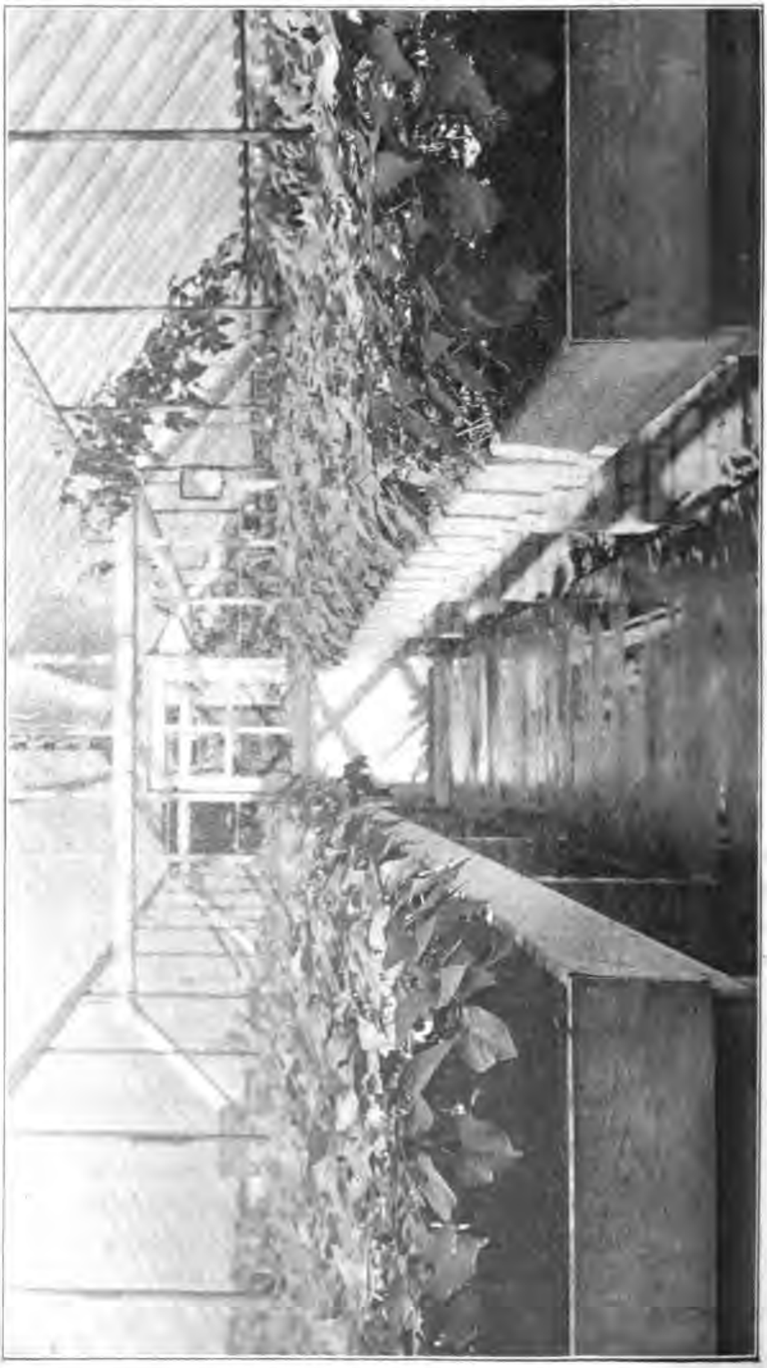


FIG. 54.—View of greenhouse used in the bean forcing experiments. (Original.)

Beans love direct sunshine, a habit undoubtedly inherited from centuries of tropical environment. They need a maximum amount of sunshine to produce the largest crops, and their maturing season may be shortened one or two weeks by planting so that they may obtain it.

The soil used in these experiments contained equal parts each of a dark, rich loam, manure and sand. The seed beds were on four greenhouse benches, two of them centre benches, 30 ft. long and 4 ft. wide, and two side benches 37 ft. long and 3ft. 6 inches wide. A fertilizer experiment was carried on in the two central benches, the side benches being used to test different ways of planting. For this purpose, Thorburn's forcing beans, the Golden-eyed Wax and the Plus Ultra green-pod beans were used.

The seed was sown directly in the beds, there being no advantage in starting them in pots, as is often advised. On the contrary it seems a waste of time and labor, as beans are very quick growers and, under greenhouse conditions, are not slow in germinating; besides, the time required by the plants to overcome the check received in transplanting exceeds by far the extra time consumed in germinating in beds. Transplanting plants tends to make the crop less and of an inferior quality.

The east bench was planted in hills about a foot apart each way, and the west bench in drills or rows about 30 inches apart, with the plants about three inches from one another. Two weeks after germinating, some sections were thinned, so that the plants were about 18 inches apart, and the other sections were left unthinned. The best results, by far, were obtained in the bench where the beans were planted in hills, but in the thinned sections a larger yield was obtained than in the sections left unthinned. In the case where they were left to grow thickly, the plants used most of their food striving to reach places where they could get enough light, as a consequence of which, the plants were more like climbers and produced but few pods and those of a very inferior quality. Besides, the weight of these few pods broke the plants down, thus making cultivation difficult. The following table shows the difference in yield in grams of the Plus Ultra beans, under different kinds of planting.

FIG. 55.—Showing the relative productivity from thick and thin planting. Short plant planted in hill; long plant in drill. (Original.)

Table VI.

	First picking.	Second picking.	Third picking.	Total.
Planted in hills	305	270	220	795
Planted in rows (Thinned).	427	360	....	787
Planted in rows (Not thinned).	450	190	....	640

The table shows that sections planted in hills, and the ones thinned, produced 795 and 787 grams, respectively, while the sections with thick planting yielded only 640 grams. The east and west benches received bottom heat and were ready for the first picking in about six weeks from the time of germination.

On the center benches the beans were planted in rows 30 inches apart, and the plants about 20 inches from each other. The benches were divided into six sections each, treating four sections of each with different fertilizers and leaving the others as checks. To section I of each bench was added a complete fertilizer, containing a half pound each of potassium nitrate and of dessicated bone, carrying 32 per cent phosphoric acid; to section II was added a half pound each of potassium sulphate and phosphates; to section III a half pound of potassium sulphate; and to section IV a half pound of phosphates. The fertilizers were applied in solution every four days, as in this way they become more quickly available to plants. From each of these two benches about three times the yield was obtained as in the other benches without fertilizers, and the quality was much superior. The following tables show the total yield of each bench giving the results in grams:

FIG. 56.—Showing growth, habit and relative productivity of Ne Plus Ultra and Golden-eyed Wax beans. Short plant is Ne Plus Ultra. (Original.)

Table VII.

	Ne plus ultra.	Ne plus ultra.	Ne plus ultra.	Golden-eyed wax	Golden-eyed wax	Golden-eyed wax
East—						
1st picking	305	420	285	580	537	455
2d picking	490	245	175	245	295	275
Total	795	665	460	825	832	730
West—						
1st picking	580	427	450	530	420	125
2d picking	300	360	190	210	180	350
Total	880	787	640	740	600	475

Table VIII.

	K.+P. +N.	K.+P.	K.	P.	No. fertilizer.	No. fertilizer.
Golden Eyed Wax—						
1st picking	1,110	890	540	305	330	....
2d picking	550	480	620	710	600	550
Total	1,660	1,370	1,160	1,015	930	550
Ne Plus Ultra—						
1st picking	530	530	810	600	170	160
2d picking	375	1,120	630	680	984	800
Total	905	1,650	1,440	1,280	1,150	930

The sections treated with complete fertilizer, composed of potassium nitrates and phosphates, yielded by far the largest crops, although the table would appear to show that the Ne Plus Ultra beans yielded less in this section than in the other section. This reduction in yield was due to the check received by the shade produced by the vines of some yard-long beans, Dolichos sesquipedalis. The sections treated with potassium and phosphates combined produced more than the sections with potassium and phosphates alone, and the latter in their turn produced much more than the ones without fertilizer. In this comparison the Ne Plus Ultra beans were found to be much more productive than the Golden-eyed Wax beans (See Fig. 56).

Table VIII shows that the Golden Eyed Wax beans yielded a larger crop than the Ne Plus Ultra, which is due, probably, to the fact that two sections of the Ne Plus Ultra were injured and stunted by tobacco smoke used for fumigation. Beans are specially sensitive to tobacco smoke.

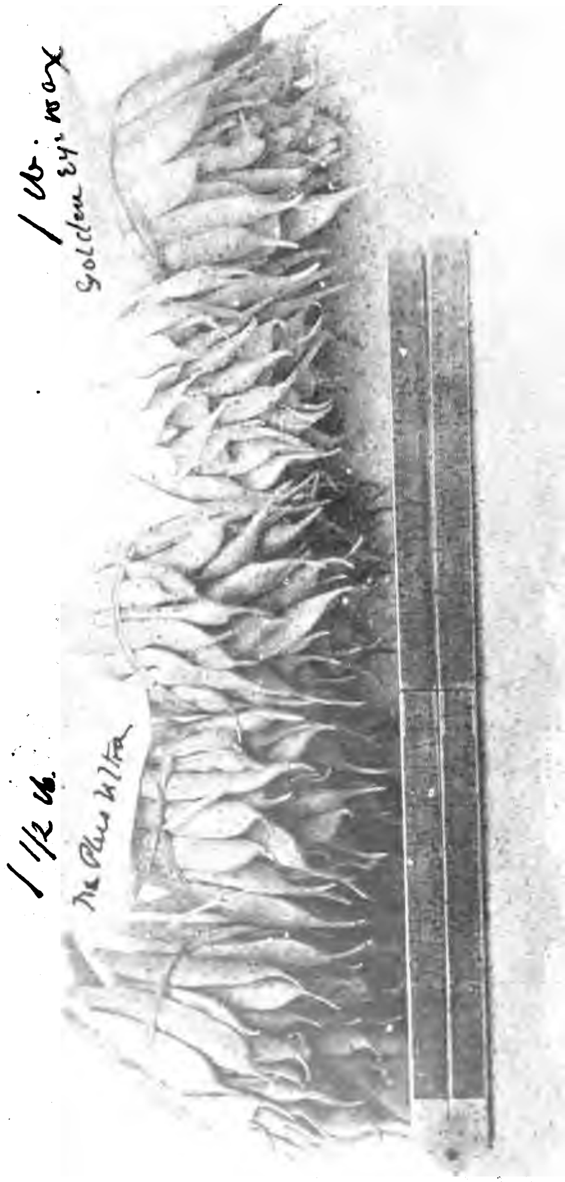


FIG. 57.—Bundles of beans ready for market. (Original.)

The only insect that was troublesome was the white fly, Aleurodes vaporium, but this was gotten rid of easily by fumigating with hydro-cyanic acid, using 10 oz. of potassium cyanide for about 6,000 cu. ft. of space. To prevent the appearance of the red spider or any fungus disease, the plants were sprayed twice a week with ammonical solution of copper carbonate.

Lastly, if we compare in the tables VII and VIII the sections without fertilizer, we see that the sections in the center benches yield much more than any section in the east or west benches where there was bottom heat. Nothing is gained by giving the plants too much heat; on the contrary, the yield is a great deal smaller, although the beans come to maturity a few days earlier, but not enough to make any great difference. The heat tends to produce a rank growth of foliage which decidedly hinders the productivity of the plants, because all the food material goes to build up the tissues of the growing parts, leaving but little for the production and maturity of seeds. About 50° to 60° F. at night and about 70° F. in the day seem the right temperatures to insure the best results for any beans.

Because of the wide range in the price of beans, we think it is advisable to have the crop mature as early as possible so as to obtain the highest prices, as the early southern grown beans cause the prices to go down considerably. This can be easily done by proper cultural methods and a wise selection of varieties. Of course, the best varieties would be ones that produce the maximum yield in the shortest time, maturing the crop in from one to three pickings. It would not pay to keep all of the space occupied by plants maturing a few pods at a time as the pods left to ripen, or left too long on the plant stop the growth and development of the other pods, thus making the fourth and fifth pickings of such poor quality that they would command but a small price.

Beans grown under glass are generally sold in bundles of half a pound each, at 20 cents wholesale price. At retail they sell from 30 to 50 cents a pound in local markets, but in large cities, 30 to 50 cents for bunches of 30 pods are considered average prices.

SUMMARY.

1. Beans should be planted in hills, or in rows or drills, so that the plants are from 20 to 36 inches from each other.

2. Beans need direct sunlight to produce their best crop, and should be kept at about 50° to 60° F. at night nad 70° to 75° F. in the day time. The house should be kept moist and the soil, also, should never become dry.

3. Beans yield their maximum crop when the soil is treated with a complete fertilizer; that is they do better with more nitrates, phosphates and potash.

4. Of the varieties tested, the Ne Plus Ultra was found to be the most productive, and also, of better quality, not being so stringy as the Golden Eyed Wax beans.

5. Beans are specially apt to be harmed by fumigation with tobacco smoke. Red spider and Aleurodes vaporium which are generally very troublesome in forcing beans are kept in check by maintaining a moist atmosphere.

The preceding article was submitted for the degree of B. S. in Agriculture by Mr. C. A. Vallejo—edited by Walter S. Brown.

SIXTH ANNUAL REPORT OF THE NURSERY INSPECTOR FOR THE STATE OF WISCONSIN.

CHRISTIAN BUES AND E. P. SANDSTEN.

The following report embodies the essential points submitted by Mr. C. Bues in his annual report of Nursery Inspection. A few changes have been made to adapt it for publication.—E. P. Sandsten.

Professor W. A. HENRY,
Director of the State Experiment Station.

Dear Sir:—As required by Section 9 of chapter 180, Laws of 1899, the following report regarding nursery inspection for the detection of San José scale and other injurious insects and fungus diseases for the year 1904 is herewith respectfully submitted.

Twenty-nine nurseries were examined against thirty last year; the name of William Elliott, Baraboo, having been taken from the list. The following nurseries are on the basis of their sanitary condition recommended for health certificates.

McKay Bros, Waterloo.
W. W. Brown & Co., Hartland.
Hartland Nursery Co., Hartland.
White Elm Nursery, Watertown.
Great Northern Nursery Co., Baraboo.
A. C. Tuttle, Baraboo.
Herbst Brothers, Sparta.
Jewett & Co., Sparta.
Hanchett & Son, Sparta.
A. D. Appletree Barnes, Waupaca.
Shiocton Nursery & Fruit Farms, Shiocton.
Hatch & Bingham, Sturgeon Bay.
Hody & Son, Sturgeon Bay.
Evergreen Nursery Co., Sturgeon Bay.

Hawkes Nursery Co., Wauwatosa.
Currie Brothers, Wauwatosa.
A. S. Fancher & Son, Corliss.
Wisconsin Nurseries, Union Grove.
Geo. J. Kellogg & Son, Janesville.
Phoenix Nursery Co., Delavan.
M. B. Downing, Milton.
Coe, Converse & Edwards Co., Fort Atkinson.
A. F. Tamblingson & Sons, Fort Atkinson.
W. H. Bright, Fort Atkinson.
Dane County Nursery, Oregon.
Henry Lake Sons Co., Black River Falls.
Cascade Nursery Co., Osceola.
John A. Salzer Seed Co., La Crosse.

INSECTS.

This year again I am fortunate enough to report to you that the San José scale has not been found in any of these nurseries nor anywhere else in the state where my duties have taken me officially or inofficially. By continued vigilance and precaution I believe Wisconsin can be kept free from this dreaded insect for years to come. The testimony of a number of fruit growers which just at this time appears in the "Rural New Yorker", shows clearly that after this pest has once become established in an orchard only the most careful and conscientious remedial measures, unceasingly administered, can keep it in check.

While engaged in my work in the state the objection was frequently raised that this insect could never endure a Wisconsin winter like that one of 1903–04. To judge by the experience of other states, this conclusion is not warranted.

One advance has been made during the last year; in the grounds of a nursery firm at Waterloo, a fumigating shed has been erected. Professor Sandsten furnished the data for the construction of this shed. It was the outcome of a demand of an out-of-state patron for fumigated stock. Such a shed is inexpensive and its operation is simple, although the fumigation should not be done by an irresponsible person as the cyanide of potassium employed in the process is a very dangerous poison.

Nurserymen are apt to forget that the inauguration of the fumigation gives them an opportunity to overcome a great deal of competition by the assurance of cleaner stock. From the business man's point of view I think a fumigating shed is an excellent investment and will bring high interest. In connection with this matter I would bring up the case of an insect which is more or less disseminated through the state and which has made itself noticeable this year again, in one case being responsible for a considerable loss of strawberry plants.

THE STRAWBERRY ROOT LOUSE, Aphis Forbesi, Weed.—The life history of this insect has been carefully worked out by Professor Sanderson in Delaware, but his data are not exactly applicable in Wisconsin as the spring season opens so much later here than in Delaware. It suffices to say that the insect hibernates in the egg stage and can, therefore, not be reached then. The little shining black eggs, which are deposited on the stems and leafribs hatch with the opening of the season and produce the wingless stem mothers, which mature in about two weeks and bring forth asexually their young alive. At the time when the eggs are hatched, that is at the time of digging of the plants, we can reach the insect by fumigation with hydrocyanic acid gas or by dipping the plants in either kerosene emulsion or tobacco solution. Regarding tobacco solution, Dr. John B. Smith says in Bull. 149, N. J. State Exp. Sta., "One pound of tobacco stems should yield one gallon of extract in two hours' boiling. If it boils down to less, add water to make up before using. The plants may remain in this mixture for several minutes, and need not be washed off after being taken out."

But the cleanest and quickest way for nurserymen is to fumigate with ¾ ounce of cyanide per one hundred cubic feet of space for twenty minutes, the plants being spread on trays in the fumigation shed or box. If the grower will but send the measurements of his box to the Experiment Station, figures and explicit directions will always gladly be furnished.

Among other enemies of the strawberry especially noticeable were the ravages of the *white grubs* and

THE STRAWBERRY LEAF ROLLER, *Phoxopteris comystana,* Froehl.—As growers tell me, this insect has been very destructive in former years. I have observed it on light sandy soils. The only means of fighting the leafroller is preventive spraying of the plants with Paris Green or other arsenites. The damage has not been large enough this year to cause growers to make great exertions towards the combating of the insect. Strawberries, raspberries and various shrubs have been very much damaged this year by the work of the

ROSE CHAFER, *Macrodactylus subspinosus.*—The presence of this insect is confined to light sandy soils and therefore, was largely noticeable where such soils prevailed. Besides clean cultivation and handpicking we have very little knowledge so far with which to fight this little light brown, long legged beetle.

INSECTS INFESTING APPLE TREES.

A number of nurseries were troubled by *Aphids* sufficiently to induce the owners to spray. In many nurseries the insect enemies of the aphids kept them in check, especially where the Lace-winged Flies (Chrysopidae-fam.) were present in great numbers.

During the earlier part of the season a little green *leafhopper* of the family Jassidae attacked the apple leaves and caused them to curl thus checking the growth of the shoot. In many instances one year old trees were seriously damaged. Several growers had sprayed their trees with kerosene emulsion, and derived benefit therefrom. It is a pest rather difficult to combat as it lives on the underside of the leaves and "hops" off quickly when disturbed. However, the young nymphs are more sluggish and tender than the old hoppers and can be easily reached. Toward the first of August the insects disappeared.

Pear and cherry trees have been injured in certain sections more than in others by the work of the

PEAR SLUG, *Eriocampa cerasi,* a dark greenish slimy looking, big headed larva of a sawfly, which works on the upper side of the leaves. A Paris green spray would check this ravage, which was considerable on cherry and plum trees.

ENEMIES TO SHADE-TREES.—Last year I reported the presence of a boring larva in Carolina and Golden Leaf Poplar. The insect in question is Cryptorhynchus lapathi, a snout beetle about one-half an inch long and it is undoubtedly imported from the eastern states. In spite of the fact that all the infested trees were removed last year, the insect which was just mating at that time got the best of us and two localities were infested with it this year. As many as twenty borers may be found in the trunk of one tree one and one-half inches in diameter. After discussing the matter, both growers found it wise to give up Carolina poplars as a nursery tree; and as the young trees were unsalable they were destroyed.

A serious question confronts us in a trouble which affects the *American Elm* our most beautiful shade tree. In three nurseries of the state I have observed elm trees infested with borers in such a way that the tops of the tree would be killed, sometimes altogether, sometimes partly. In one instance I have seen a few young trees entirely killed. On emerging the borer leaves a hole of 1–16 of an inch in diameter; many borers working in one tree, tunnelling along in the solid wood, parallel to the bark. As I could secure only a few immature larvae I have not been able as yet to determine the identity of the insect. Where the insect was present we have resorted to severe pruning to combat it. I shall devote some time toward an investigation into the nature of this trouble and hope to be able soon to report to you the results.

The soft maple scale "*Pulvinaria innumerabilis*" is very prevalent in many parts of the state and is causing considerable concern, and some means should be devised to destroy this pest cheaply.

The ravages of the *Onion Maggot* in the vicinity of Shiocton are increasing and a close study of the situation there seems advisable. Measures might be introduced to check the insect to some extent next year. The feeling of growers is rather depressed. The insect can be controlled to a great extent by rotation of crops. Onions should not be grown on the same land for a number of years as is usually done. When the land has once become infested it is almost impossible to keep the insect from damaging the crop.

FUNGUS AND BACTERIAL DISEASES.

While public opinion says that apple blight is worse this year than before my observations compared with last year's notes show that this is not the case in the regions which I have visited. It is a difficult matter to battle with blight and the average farmer does not find the time to do it properly. After discussing this point thoroughly with a number of our leading nurserymen we concluded that it might be a very useful measure to propose to the State Horticultural Society to advocate the removal from the list of fruits adapted for the State of Wisconsin, as specially subject to blight, the following varieties of apples: Winter chief; Yellow Transparent; Transcendant Crab.

CROWN GALL.

Professor Sandsten made Crown Gall the subject of a paper before the State Horticultural Society last winter. It is a treacherous disease and hard to fight. Last year during my inspection work a good many trees were destroyed, so there were this year, but I am unable to wage war on this fungous trouble successfully at this time of the year. When the trees go to the packing shed is the time to attack the gall, for only then can it be found. Rotation of crops is the best weapon in the hand of the nurseryman. Be careful where you buy your roots, and plant on clean land, and burn all the infested trees.

THE TWIGFORM OF THE PLUMPOCKET DISEASE, (*Exoascus pruni*), should be combated where it appears in nurseries. We have done so this year by burning the infested twigs.

THE RASPBERRY CANEBLIGHT, *Comiothyrium fluckelli,* which Mr. Thro reported from Janesville, is present in several localities, but the beds are not used for propagating purposes. Severe pruning does a great deal where the infestation is not too bad. Raspberries should not be allowed to reach too great an age before they are pulled up. Shorter rotation will pay in increased productivity.

ASPARAGUS RUST, *(Puccinia asparagi,* D. C.*)*.—This dreaded disease has entered into the list of our enemies in the state and what is worse than an attack in the field for cutting, I

and was found in two plots of two year old plants ready to market next spring. The tops of the plants were mowed close to the ground and burnt and the remaining stubble well sprayed with Bordeaux mixture.

COLLECTION OF INSECTS.

When travelling through the state and stopping in various sections, representing great differences in climate, humidity, elevation and flora, an opportunity is offered for the collection of many insects of present and future economic value.

The material which I thus secured, was classified and prepared at the University to be used in the class room. They will serve to familiarize the students with the most common insects and fungi on the farm and in the orchard.

APPENDIX.

The following is a supplementary list of economic insects noted in the state, which would invite a close observation in future.

Supplementary List of Economic Insects.

Common name.	Technical name.	Locality.	Remarks.
Poplar Leaf-folding Sawfly.	Pontania bozemani Cooley.	Fort Atkinson.	Work found on Carolina Poplar.
Elm-boring Snout Beetle.	Hagdalis armicollis.	Madison.	On American Elm.
Budmoth.	Tinctocera ocellana.	Waterloo.	On Apple very injurious.
Scuffy Scale.	Chionaspis furfurous.	Corliss.	On Apple.
Woolly Aphis.	Schizoneura lanigera.	Scattered in the state.	On nursery stock, bark and roots.
Spiny Elm Caterpillar.	Evanessa antiopa.	Oregon.	On Elm.
Plum Curculio.	Conotrachelus menuphar (Hbst).	Madison.	On Plum.
Currant Sawfly.	Nematus ribesii.	Baraboo.	Stripping currants.
Imported Currant Borer.	Lesia tipuliformis.	Fort Atkinson.	Larva in young currants.
Blackberry Crown-borer.	Bembecia marginata.	Sparta.	On Blackberries.
Snowy Tree Cricket.	Occanthus nivens.	Sparta.	Injures blackberry-canes by egg-slits.
Strawberry Weevil.	Anthoriomis signatus.	Sparta.	Damaging apple trees in nurseries.
Apple Louse.	Aphis fitchii. Aphis sorbi.	....	
Peach-tree Borer.	Samina exitiosa.	Sparta.	On Plum—destroying many trees.
Onion Maggot.	Phorbia ceparum.	Shiocton.	Ruining onion industry.
....	Cryptorhynchus lapathi.	Wauwatosa. Corliss.	On Carolina and Golden leaf poplar—killing trees.
Strawberry Root Louse.	Aphis forbesi.	Fort Atkinson.	Very noticeable on Elm.
Cockscomb Galls	Calopha ulmicola.	Delavan.	On Elm.
Black Cherry Aphis.	Aphis persicae-niger.	Baraboo.	Injuring Cherries.
Bollworm.	Heliothis armiger.	....	Boring in corn-tassel.
Poplar Leaf Miner.	Pachard, F.—T., p. 479	Fort Atkinson.	On Carolina Poplar.
Putnam Scale.	Aspidiotus ancylus.	Sturgeon Bay (1903)	On Plum.
Elm Scale.	Aspidiotus ulmi.	Madison.	On Elm.
....	Thycerus noveboracensis.	Watertown.	....
White-spotted Tusseck Moth.	Notolophus leucostigma.	Milwaukee.	Great nuisance on shade trees.

SOME OBSERVATIONS ON THE BOTRYTIS ROT AND DROP OF LETTUCE.

H. J. RAMSEY.

Several attempts were made during the last winter to grow head lettuce in the Experiment Station greenhouses, but all were, more or less, unsuccessful due to the presence of Botrytis or drop disease. The head varieties of the lettuce are much more susceptible to the attack than the Grand Rapids type, though even the latter is occasionally attacked. Even the most experienced growers find trouble in carrying through a crop of head lettuce in winter in perfect condition, and it requires the greatest vigilance and careful attention to successfully and profitably grow it. Unlike most greenhouse crops, it is the foliage which constitutes the desirable part of the plant and every leaf must thus be carried through in a well nigh perfect condition.

There are three main points to be kept in mind in the growing of lettuce, namely: temperature, ventilation, and moisture. The temperature should be at least 10° lower at night than during the day. The ventilation should be of the best and the air be as free from moisture as possible.

There is considerable discussion as to the methods of watering the plants, but watering should be done in such a manner that the foliage remains dry, especially after the crop is half grown. Sub-irrigation has been tried by many with great success.

One whole house was devoted to the culture of lettuce during the past winter and little trouble was anticipated because the house was but recently constructed and the soil was fresh

and supposedly free from fungi. The lettuce seeds were first sown in boxes and transplanted once before they were set out in the benches. They grew vigorously and to all appearances were in a healthy and normal condition till some time before they were ready for market. A sort of tip burn was the first indication of any trouble, and examination was immediately made for fungi, but no trace of any mycelium was found, nor was there any indication of bacteria or pathogenic diseases. For two or three days, the tip or top burn which first appeared as a brownish tint turned to a buff brown color and upon examination, the characteristic mycelium of Botrytis cinerea could be discerned in the tissue.

The inner and more tender leaves of the head were first attacked. With the appearance of the hyphae in the tissue, the disease appeared to be working down toward the bases of the leaves and into the heart of the plant. After the inner tender leaves of the head had been attacked, the progress of the fungus was very rapid. The succulent condition of the leaves and their tendency to retain the moisture make them an ideal place for the development of the disease. It was evident that, in the majority of cases observed, the infection took place at the tip of the leaves, but before the spores could germinate there must have been a wound or partial decay aided by sufficient moisture and high temperature. The tip burn, which, as far as could be determined, was caused by no disease either bacterial or fungal in nature, must have been due to some physical cause or functional disorder. After the appearance of this watery decay on the leaves, the characteristic gray mold appeared upon the surface of the leaves. This mold was the fruiting bodies, or the conidia of the fungus living in the tissue of the host. The whole leaf portion from the tip down gradually became attacked. The attack was not confined to the mid-rib alone, though the disease sometimes made greater progress along the mid-rib and larger veins than through the leaf blade itself. The mycelium could be seen ramfying in all directions, though the general trend was downwards toward the base. The leaves became limp and lost their turgor and finally fell away from the center of

the head and soon the whole head became sufficiently infected to be entirely worthless.

This same fungus is very frequently found on decaying organic matter, and is then a true saprophytic plant; but in the above case it assumed a parasitic character and lived on living leaves, though we have not succeeded in infecting healthy plants from the spores of the fungus under ordinary conditions. A perfectly healthy plant cannot be infected by placing on it a portion of the infected plant in the watery decay stage. This seems to indicate that the fungus is not truly parasitic, but that, when once an entrance is gained through a previous wound or decay of some sort, it will readily and quickly assume a parasitic habitat and completely infest and destroy the remaining leaf tissue of the plant. It is very probable that this decay is brought about in the same way as that caused by their closely related forms. The hyphae seem to exude an acid or enzyme which is poisonous to the lettuce cells, and this fluid being exuded from the hyphae next to the leaf tissue kills the cells immediately adjacent to the mycelium, and, as the mycelium advances in this partially killed tissue, the zone of the fluid from the hyphae advances and continually kills the tissue the mycelium advances in. In this way there is always a zone of partially killed tissue in which the mycelium of the fungus advances. Though the results are those of a parasite, the Botrytis itself is not truly a parasite, but rather a saprophytic or semi-parasitic plant, living on the dead or partially dead tissue. The exudation of the fluid by the fungus may not, at once, bring about the stoppage of the life processes, but sufficiently interferes with and retards the normal protoplasmic activities of the plant, so as to allow the Botrytis mycelium to flourish. This character of the disease seems to partially account for the fact that we cannot infect healthy plants from the spores of conidia of Botrytis, but the infection can be made if the tissue is wounded. This accounts for its great ravages when once started.

Numerous experiments were made to inoculate healthy plants from the spores alone, but only when the plant was placed under a bell jar and well watered, could we succeed in

infecting a perfectly healthy plant. Afterwards a good many cases of infection by this fungus were observed, and it was found to start from various places other than the tips of the leaves. In a good many cases, it would start where the tip or the base of the leaf was in contact with the soil and from the place of contact it would work its way slowly towards the stem. The leaves, after the end of the characteristic watery decay stage, turn a buff brown or else, in some cases, being attacked by other saprophytic fungi, turn black.

What is termed black rot was observed in but very few cases. Here the infection was usually observed to be at a place where the leaf was in contact with the soil and the mycelium would gradually grow up the mid-rib and veins and reach the stem. After a while, the leaves would fall away leaving dark spots where they had once been attached. Because of this character of the disease, it has been termed black rot.

The first attack of the drop fungus was characterized, first, by a tip burn which may have been a physiological disorder, but formed the gateway, as it were, for the fungus; second, a partial drying up of the leaf with the buff brown color and the presence of hyphae in the tissues; third, the watery decay stage where the leaves become limp and flabby and covered with the spores of the fungus. After the appearance of the characteristic gray mold on the leaves, the leaves either dry up or are attacked by other saprophytic molds and fungi. The disease has been known for many years, but has been little observed in the west, due to the fact that but little head lettuce has been grown in the greenhouses thus far.

As far as our observation goes, the infection in the new house was wholly due to spores floating around in the air, and only in few cases where the outside leaves were in contact with the soil could the fungus have gained an entrance to the leaves from the soil. Most of the cases of infection where the leaves were in contact with the soil took place after the disease had become quite prevalent in the house when the spores were copiously distributed through the soil. When first noticed, the mycelium was found only in the tips of the leaves while the rest of the plant was perfectly healthy and in no wise

infected with fungus. A few cases were observed after the first crop had been harvested where the stem seemed to be attacked immediately below the leaves and the nourishment cut off from the head due to the rapid spread of the fungus. Consequently the plant succumbed. This, undoubtedly, was a case of the drop and not Botrytis cenerea, though it is possible that the Botrytis had gained an entrance into the stem by means of some previous wound or partial decay. A close examination was made for sclerotia but none was found, nor was there any fungus threads to be seen in the soil. All goes to show that infection must have taken place from spores. Numerous pure cultures were made, both of the conidia of Botrytis and of portions of leaves containing the hyphae. The spores germinated very readily in ager-ager in which was mixed a decoction of lettuce leaf. The leaves of lettuce were first boiled and the resulting decoction thoroughly mixed with ager-ager. The spores germinated in less than twelve hours and continued to grow and develop until the conidiafores, bearing the conidia, were formed. Fig. 59 (a) shows the characteristic appearance of Botrytis spores. When portions of the leaves containing mycelium were placed in cultures, mycelium would continue to grow, form conidiafores, and conidia. As seen in figure 58 (d), the conidia are borne in masses at the ends of the conidiafores. In only two or three cases were there any signs of the formation of sclerotia and then only after being grown in cultures for several weeks. If one should examine a leaf of lettuce infected with the Botrytis, he would find that the mycelium which grows inside the mesophyllum of the leaf is somewhat different from the mycelium which produce the conidiafores. Figure 58 (a) shows a gradual development from a hyphae thread to a conidiafore on the outside of the leaf. The hyphae in the mesophyll tissue is larger and the protoplasm more dense and granular. The general character of the soil has little to do with prevalence and progress of the fungus. Lettuce grown in plats with different kinds of soil was about equally attacked and it could hardly be expected that one would be more immune than the other since the infection,—as far as could be judged,—took place through the tips of the leaves. It is possible, however, that the character

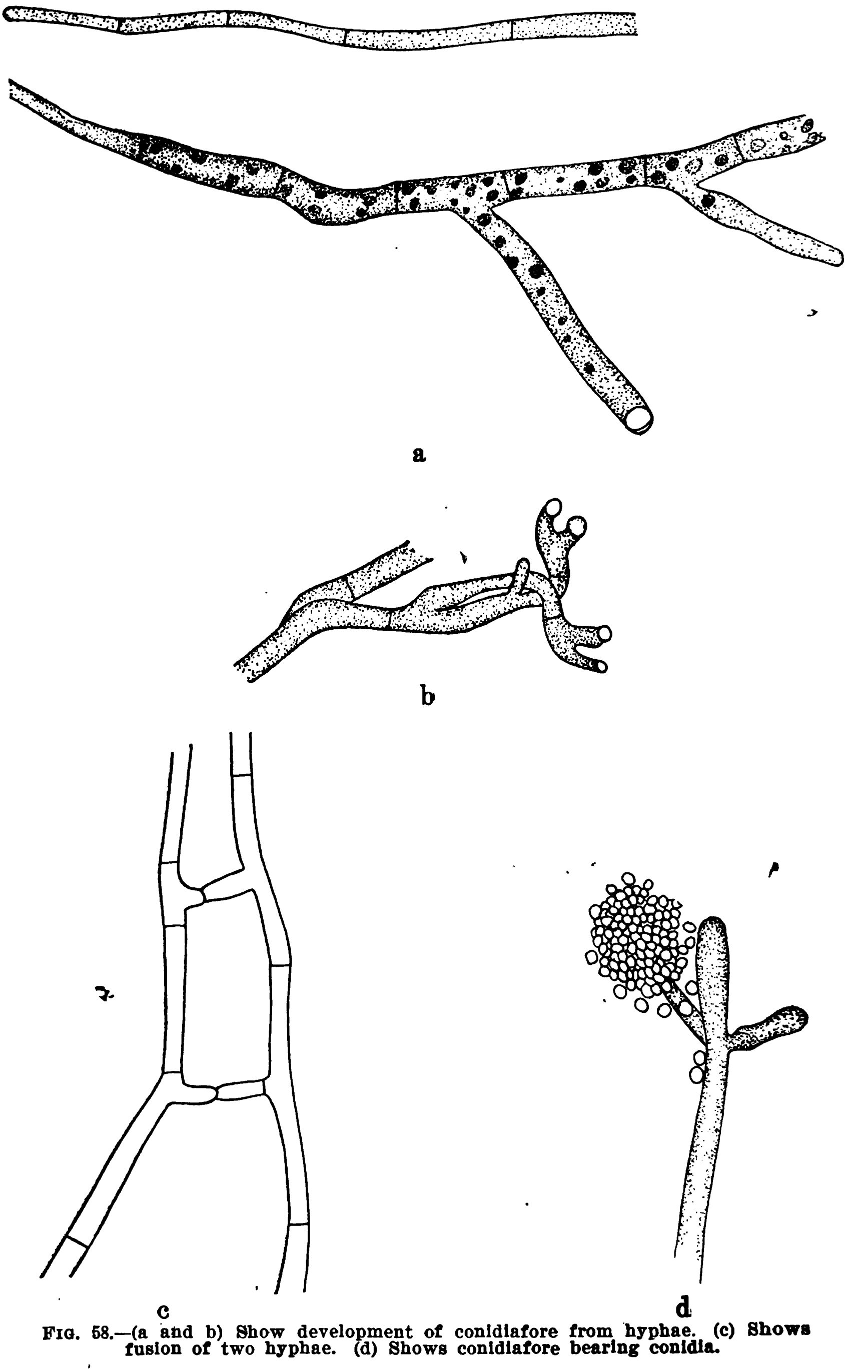
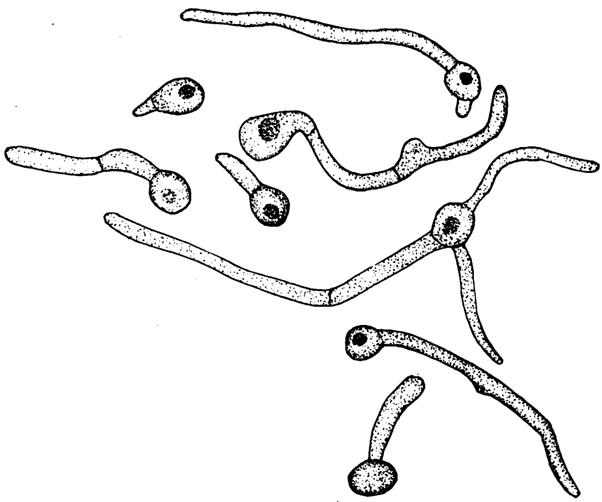
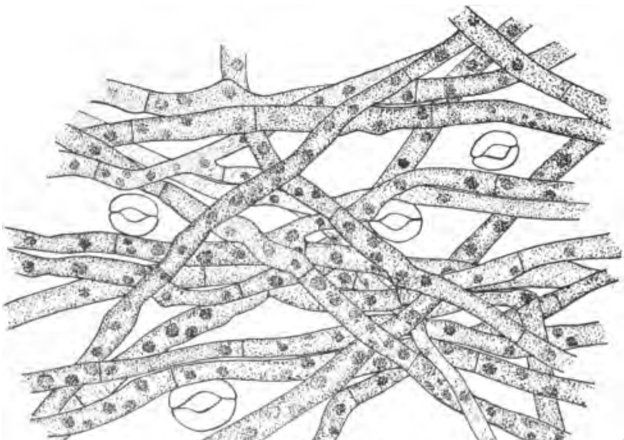


FIG. 58.—(a and b) Show development of conidiafore from hyphae. (c) Shows fusion of two hyphae. (d) Shows conidiafore bearing conidia.



a



b

FIG. 59.—(a) Shows germinated conidiafores. (b) Cross-section of a lettuce leaf showing ramification of the hyphae.

of the soil has something to do with the appearance of the tip burn, though the tip burn was as prevalent on the lettuce of all the plats.

The spores of the Botrytis cinerea must have, in some way, been brought into the house and commenced to develop as soon as favorable conditions offered themselves.

Later in the winter, a second greenhouse was planted to head lettuce, which nearly reached maturity before it was attacked by any fungus and there were but few cases of the typical Botrytis present. All possible precautions were taken in reference to ventilation, temperature and moisture. The plants were not sub-irrigated but were watered in such a manner that no water was allowed to come in contact with the foliage of the plant and by this means the heads were kept dry and the experiment was quite a success.

The burning of sulphur to kill any spores that were present was not very satisfactory, especially in the first house, where, in spite of all reasonable care, the plants were slightly burnt by the sulphur. Even if the spores did not survive, the fungus in the soil and in portions of the plant was not killed and new spores were soon formed. The plants having been burned by the sulphur were more open to attack than ever, and the spores soon commenced to germinate freely on the injured portions of the plants and made a vigorous growth. So, after all, the disease was but temporarily checked and the way paved for a much more vigorous spread of the disease. In the use of sulphur, great care should be taken to bring about an even distribution of the fumes, as they are very likely to be carried along by any movement of the air. Even if the house is shut up so that ordinarily there are no currents of air, the burning of the sulphur tends to destroy the equilibrium of the atmosphere in the house and bring about currents; so the higher up the pan in which the sulphur is to be burned can be placed the more equal will the distribution of the fumes be. It would also be well to generate the fumes inside of an oven and so in a measure prevent the formation of air currents. The sulphur treatment has been used successfully by some growers of lettuce. If the Botrytis or, as it is sometimes called, the mildew should appear shortly before the plants are

to be harvested, the disease could be materially checked by the judicious use of sulphur.

It was not Botrytis but the typical drop, Sclerotina libertina (Fckl), which caused the damage to the crop in the second house. Here the plants were not planted in benches but were set in a solid bed. Originally the greenhouse was used as a garden house for demonstrations in garden craft and the soil had become mixed with chemicals injurious to plant growth. Many of the plants made a poor growth on this account. Those plants then which were held back first by these soil conditions were the first to succumb to the disease. The plants would all be in a healthy condition—or apparently so— at night, while perhaps in the morning several would be found nearly or wholly collapsed, the leaves having become limp and flabby with a loss of their normal color and turgor. In a short time the leaves would be covered with a growth of hyphae giving them a whitish appearance, but upon examining the surface of the leaves no spores could be found. In a few cases leaves which had been killed by the typical drop were afterwards infested with the Botrytis, but this was of but secondary importance as the Botrytis in this case was saprophytic in character. When attacked by the drop whole plants would collapse at once as if the stem had been severed from the roots, thus cutting off the transference of food. Upon examination, the stem, roots, and basal portions of the leaves were found to be completely infested with hyphae, seemingly those of Botrytis cinerea, however the infection took place here from the roots and stems, and the leaves decayed after the injury to the stem and roots. The fungus is a very rapid grower and very active as shown by the little time required to entirely collapse the plant. It seems too as if the nourishment is cut off and the plant succumbs as a result. Upon examining the soil, hyphae were also found abundantly in it. This shows that it can live as a saprophite as well as a parasite. Sclerotia were found in the soil as well as at the bases of the leaves, but in no case were spores found. These sclerotia are but dense wefts of hyphae aggregated to better withstand the dry and variable conditions. Numerous cultures were made of the mycelium found in soil on both the stem and the leaves, but in no case did these produce conidia though sclerotia were quite readily produced.

It thus seems so far as our present knowledge goes that the fungus continues its existence without forming spores and lives from year to year in the soil, usually in the form of sclerotia. Thus in a greenhouse it is a very easy matter for the fungus to continue its purely vegetative existence and, being in the soil, it will attack lettuce whenever it is planted in that soil. The mycelium is very similar to that of Botrytis and is indistinguishable from it. It is only by their different characteristics in attacking lettuce that they can be distinguished without making cultures of them, when they can readily be told from each other. Botrytis cinerea, as has already been described, has a watery decay stage followed by the gray mold or spores on the surface of the leaves while the latter forms no spores, but can usually be distinguished by the sudden collapsing of the whole plant. The former reproduces itself by means of spores while the latter continues its existence in a vegetative state. Several experiments were made in infecting healthy lettuce from soil which was known to contain drop fungus, and in nearly every instance the plants would suddenly collapse when nearly matured. A good deal of work has been carried on by the Massachusetts Experiment Station especially in reference to remedies for the drop. It was there found that one of the most efficient methods of prevention was the complete sterilization of the soil or at least of a layer three inches deep.

It is probable that the two are entirely different fungi, as in no case have we been able to produce one from the other and, if they once were the same, each one has now become so fixed in its habit that it is impossible to produce one from the other. But a brief description of the methods of attack by the two different fungi has been given, for as yet not many experiments have been carried on by this Station with reference to controlling the disease. When lettuce is again grown in the house the next season the work will be primarily along the line of prevention of the disease.

The growing of head lettuce would probably be as profitable near some of our larger cities in the West as it is in the East if some means of prevention could be found to guarantee against the ravages of these two fungi.

EXPERIMENTS WITH GRAIN AND FORAGE PLANTS 1904.

R. A. MOORE AND A. L. STONE.

For the year, 1904, variety tests were made at our Experiment Station, with oats, barley, rye, wheat, peas, corn, soy beans, clover, alfalfa, etc. The tests were confined to those varieties of grains and forage plants that had shown superior characteristics over common varieties through tests continued for several years, and which we thought of sufficient merit for further trial. In the comparative tests of grains, the needs of the actual farmer are kept constantly in mind, and the grain is grown on small or large plots under ordinary conditions. The machinery used is the same as that used on the average farm, and the soil is tilled and given approximately the same treatment as that given to land by the careful farmer. The yields obtained, consequently, are not above those which can be obtained on the best farms within the state.

A. SMALL GRAINS.

Oats.—Many of the varieties formerly tested, were this season discarded and trials carried on merely with those varieties which have shown desirable characteristics through several years' tests. Eighteen varieties of oats were tested this year on the experiment plots, and notes taken from time to time in regard to general and special characteristics of the plants, as length and stiffness of straw, rust resistance, color, size and plumpness of berry, smut present, stooling qualities, root development, growing period, and yield per acre.

In regard to the development of kernels of grain in the oat plant, we classify them as single oats, double oats, twins and triplets.

The single oats have but one berry underneath the glume, the double oats have two berries closely attached, the smaller of the two seeming to be a part of the larger and partially within the same hull.

The twin oats have two fairly good-sized berries beneath one glume, and the triplets have three. The berries in the twins and triplets are connected by a hair-like thread, which is severed when threshed. The twin oats are preferable, as these are nearly uniform in size and weight. The triplets have many small oats, often without meat.

The Swedish Select oats (Wisconsin No. 4) are the most satisfactory oats on trial. In point of yield, this year they were somewhat below some of the other varieties, but the plots were located in a portion of the field affected by the spring overflow, and some of the plants were buried beneath sand, and otherwise injured which reduced the yield.

These oats are now being grown extensively by members of the Wisconsin Experiment Association, and nearly all reports received speak of them as heavy yielders and satisfactory in every respect.

The stiffness of straw, and the fact that approximately sixty per cent of the Swedish Select are twin oats make them desirable.

Farmers and seedsmen desiring a list of growers of Swedish Select oats, (Wisconsin No. 4), will be furnished the same on sending request, addressed: Secretary, Wisconsin Experiment Association, Madison, Wisconsin.

Barley.—Thirteen varieties of barley were tested. Six six-rowed and seven two-rowed barleys were under test. The six-rowed barleys surpass the other varieties in point of yield and in ability to stand up well, but the two-rowed varieties are heavier per measured hushel. The Manshury seems to be the most satisfactory barley on trial through a several years' test; the Golden Queen and Silver King, which the writers believe came from the Manshurian stock and are changed in

name only, show all the good characteristics found in the Manshury.

The Oderbrucker barley which is a stiff-strawed, six-rowed barley, has given great promise in point of yield and desirable characteristics, and seems to rival the Manshury barley as regards yield, and to surpass it in weight per measured bushel. To determine the desirable qualities of the Manshury and Oderbrucker varieties of barley, samples were sent to the Wahl-Henius Institute of Fermentology at Chicago, for analysis. The report made by this institution showed the Oderbrucker to have an albumen content of fifteen per cent, while that of the Manshury was thirteen per cent. The analysis of the Oderbrucker barley showed it to be very high in that element that is most important to, and desired by feeders of live stock, but we are not sure that the high albumen content would be desirable for brewing purposes as many brewers and maltsters seem to prefer barley of a low albumen content.

Arrangements are being made to supply the Wahl-Henius Institute with one hundred bushels of the Oderbrucker barley for the purpose of conducting a malting test, to determine the value of this high-albumen barley. Until this test is made no barley of this variety will be obtainable, as it might seriously injure the barley market by having barley of a high-albumen content grown and marketed with that of a low-albumen content. Analyses have not as yet been made of the beardless, hulless, and two-rowed varieties, as the Station does not think it advisable to introduce, except for experimental purposes, varieties of barley that may in any way react against the standard of Wisconsin barleys. No beardless or hulless barleys were grown the past season on the Experiment farm.

It seems that it is far better for an entire community or district to grow one standard variety of barley than to grow several varieties of different standards. One of the desirable characteristics sought by grain buyers is uniformity of product, which cannot be obtained if farmers insist on growing many varieties of the same grains. Where the grain is fed on the farm it may not matter much, but where the desire is to market the same, it is well for all to grow the particular variety which the market demands.

There are certain localities in the state that seem especially favorably situated for growing barley, and can produce this crop better than other localities and better than other cereal crops. For instance, in southern Wisconsin, through Walworth and Rock counties, the oat crop is apt to rust badly, and the rust reaches that advanced stage which encrusts the stems of the oat plant, making them brittle and preventing the heads from filling. This section of the state grows beautiful barley, which takes on a golden hue, that is especially characteristic of the barley grown in this locality.

It seems advisable for farmers living in this section, to emphasize growing barley and give up for a few years, at least, the growing of oats. By so doing this section would soon become a barley center, and better prices could be obtained for the product on account of the quantity and the quality of the crop, than is the case where only small quantities are grown.

Rye.—Two varieties of fall rye, the Petkus (U. S. No. 5,058) and Schlansted (U. S. No. 5,031) were again tested on the Station plots. These varieties have given good returns in the past and promise well for the future.

B. LEGUMINOUS CROPS.

Peas—A yellow variety, the original seed of which was secured from the Minnesota Experiment Station in 1902, was again sown and gave good returns. This variety does not appear to be so badly infested with the weevil as is characteristic of many of the other varieties grown in this section of the state.

The yields and other data of grains grown on the Experiment plots is given in the following table:

Yield of grain and straw in variety tests of cereals, 1904.

NAME OF VARIETY.	Wisconsin number.	Origin of seed.	When received.	Date of sowing.	Days maturing.	Seed per acre.	YIELD PER ACRE Grain (By wt.)	YIELD PER ACRE Straw.	Weight of grain per measured bushel.
				1904.		Bu. Pk.	Bush.	Tons.	Pounds.
Oats.									
Siberian	1	Ontario, Canada	1899	April 23	96	2—2	64	2.4	32
Poland White	3	Ontario, Canada	1899	April 23	96	2—2	56	2.4	30
Swedish Select	4	U. S. Dept. Agr., No. 2,788	1899	April 23	95	2—2	62	2.2	32
Tobolsk	6	U. S. Dept. Agr., No. 2,800	1899	April 23	100	2—2	43	2.1	32
Early Gothland	8	Minn. Exp. Station, No. 26	1900	April 23	100	2—2	64	2.1	32
Big 4	12	Salzer Seed Co	1900	April 23	100	2—2	51	2.2	29
Bow of Promise	13	Salzer Seed Co	1900	April 23	100	2—2	52	2.9	26
Lincoln	15	Minn. Exp. Station, No. 23	1900	April 23	100	2—2	52	2.2	26
White Bedford	17	Minn. Exp. Station, No. 85	1900	May 20	80	2—2	31	4.7	23
White Wonder	21	Minn. Exp. Station, No. 32	1900	May 20	100	2—2	44	2.5	25
Sunshine	23	St. Charles, Ill	1903	May 20	99	2—2	58	3.0	25
Silver Mine	25	Columbia Co., Wis	1900	May 20	99	2—2	44	2.0	28
Iowa Silver Mine	26	Iowa Exp. Station	1900	May 20	100	2—2	47	1.7	26
White Belgian	28	Iowa Exp. Station	1900	May 20	100	2—2	58	1.6	34
Wisconsin Wonder	34	Jefferson Co., Wis	1900	May 20	100	2—2	60	2.4	31
American Banner	36	Fond du Lac Co., Wis	1901	May 20	100	2—2	51	2.5	27
White Shonen	39	Fond du Lac Co., Wis	1903	May 20	100	2—2	47	2.1	26
Belyak	40	U. S. Dept. Agr., No. 10,624	1904	May 14	86	2—2	33	1.6	29
Barley.									
Silver King	3	Salzer Seed Co	1900	April 30	86	1—2	34	1.4	48
Manshury	4	Ontario, Canada	1899	April 30	89	1—2	52	....	49
Oderbrucker	5	Ontario, Canada	1899	April 30	87	1—2	48	....	50
Golden Queen	11	Minn. Exp. Station	1899	April 30	84	1—2	35	....	49
Svanshals	16	U. S. Dept. Agr., No. 5,474	1901	April 30	87	1—2	36	2.9	49
Princess Korn	18	U. S. Dept. Agr., No. 5,472	1901	April 29	87	1—2	38	2.4	51
Hanna	19	U. S. Dept. Agr., No. 5,793	1904	April 30	93	1—2	36	1.6	50
Chevalier	21	U. S. Dept. Agr., No. 10,584	1901	April 30	96	1—2	35	2.2	51
Hannchen	22	U. S. Dept. Agr., No. 10,585	1904	April 30	92	1—2	39	1.8	52
Princess	23	U. S. Dept. Agr., No. 10,583	1904	April 30	97	1—2	38	1.9	52
Primus	24	U. S. Dept. Agr., No. 10,586	1904	April 30	92	1—2	48	2.0	51
U. S. No. 7,583	25	U. S. Dept. Agr., No. 7,583	1904	April 30	83	1—2	24	1.2	43
U. S. No. 7,584	26	U. S. Dept. Agr., No. 7,584	1903		Did not mature or even produce heads				
Wheat.									
Iowa Winter	16	Iowa Exp. Station	1903	Sep., 1903	....	2	13 1-5	.8	60
Peas.									
Minnesota Yellow	....	Minn. Exp. Station	1902	May 5	104	2	38.5	....	60

Soy Beans.—Ten varieties of soy beans were tested to determine their value as a forage and grain-producing crop. The yields and other data relating to the crop are given in the following table:

Name of Variety.	Wisconsin No.	Origin of seed.	When received.	Date of sowing.	Days maturing.	Seed per acre.	Yield of grain by weight.	Weight per meas bushel.
			Year.	1904.		Qts.	Bus.	Lbs.
Wisconsin Black	2	U S Depart. Agri.	1902	May 4.	139	8	20	59
Ito San	3	E E.Evans,W.Br'nch,Mich	1902	May 4.	149	8	$15\frac{5}{6}$	56
Medium Early Black...	4	E E.Evans,W.Br'nch,Mich	1902	May 4.	149	4	$10\frac{5}{6}$	56
Early Brown............	5	E.E.Evans,W.Br'nch,Mich	1902	May 4.	148	8	$20\frac{5}{18}$	58
Medium Early Green.	6	E E Evans,W.Br'nch,Mich	1902	May 4.	152	8	$21\frac{1}{3}$	57
Early Yellow...........	7	E E.Evans,W.Br'nch,Mich	1902	May 4.	144	8	$16\frac{5}{6}$	56
Early Black...........	8	E E.Evans,W.Br'nch,Mich	1902	May 4.	146	4	$17\frac{1}{3}$	56
Best White	9	U. S. Dept Agr. No. 4.913.	1902	May 4.	169	8	23	56
U. S. No. 9,408	15	U. S Dept. Agr. No 4,913.	1903	May 4.	169	8	$18\frac{1}{2}$	58
U. S. No. 9,407	16	U. S. Dept. Agr. No. 4,913.	1903	May 4.	176	8	$24\frac{1}{2}$	59

From past experience with soy beans, the Experiment Station has determined that the earlier varieties can be matured successfully in southern Wisconsin. The U. S. No. 9,407 and the Early Brown variety gave a yield of 50 and 40 bushels of dried beans, respectively, in 1903, but the yield was much lighter in 1904 on account of the unfavorable weather conditions. Soy beans are very high in nitrogen content which makes them an excellent feed for farm animals, where the desire is to use concentrates to form balanced rations with carbonaceous foods.

Analyses made by Mr. Geo. A. Olson, of this Station, of soy beans are given herewith:

Soy bean analyses.

Moisture.	Protein.	Fat.	Crude fiber.	N. free extract.	Ash.
10.53	36.25	16.90	4.15	25.97	6.20

Planting and Cultivating Soy Beans.—The land should be prepared in the same manner for soy beans as for corn or small grains and the beans sown at the time of corn planting, and cultivated with the same tools and in the same manner as corn. Soy beans can be sown broadcast or in drills. If the desire is to cut them for hay they should be sown broadcast, using about one bushel per acre. Where the beans are to be har-

vested and threshed, they should be sown in drills about thirty inches apart between the rows, and about four inches apart in the row. When sown in drills, a hand planter can be used, or a grain drill can be used by stopping the intervening spouts so that the beans will be dropped at the proper distances apart. An ordinary corn planter can be used and beans drilled the full width of the planter (which is usually forty-two inches), or by straddling each row with the planter they can be put in twenty-one inches apart. Where rows are put in as closely as twenty-one inches apart, the seed should not be sown so thickly in the row as when sown at a wider distance. One peck of seed is sufficient to sow an acre where the rows are thirty inches apart and the beans about four inches apart in the row. Soy beans can be sown with corn, using one-third soy beans and two-thirds corn, and a mixed crop raised for silage purposes.

Soy beans have been grown with corn for the past three seasons at this Station and can be readily harvested with the corn. When the crop is gathered with a corn harvester the bundles can be taken to the silo and run through the cutter for silage, or shocked in the field and cured for fodder.

Soil Inoculation.—The soy bean belongs to the family of plants known as *leguminosae;* through the action of certain micro-organisms which inhabit nodules that grow upon its roots it appropriates nitrogen from the air for the benefit of the plant. These nodules left in the soil decay when the plants ripen, thereby leaving a considerable quantity of nitrogen in the soil. From numerous tests made, covering several years, we find that if soy beans are planted on land which has not before grown this crop, it requires from three to four years' continuous growing before all plants develop the bacteria-laden nodules upon their roots. It seems that unless the nodules are present, little nitrogen will be appropriated from the air.

In order to facilitate the development of nodules, bacteria-laden earth taken from a field that has grown soy bean plants, the roots of which had nodules upon them, can be scattered on the surface of the field where soy beans are to be grown,

and the plants will then grow the nodules during the first season of planting. Bacteria-laden soil can be mixed with the soy beans at the time of planting and run through the drill, thus inoculating the soil, or scattered over the field and dragged once, previous to planting. The latter way is preferable, as in the former the soil in the planter is apt to obstruct the dropping of the beans and the stand will not be uniform.

By growing soy beans with corn and inoculating the soil, the farmer will not only get a superior grade of fodder but will have the soil partially enriched as well, by the decaying of the nodules growing upon the roots of the soy bean plants.

SUMMARY.

1. The earlier varieties of soy beans can be grown as grain and forage plants in most portions of Wisconsin.
2. A sandy or light clay loam is preferable for growing soy beans.
3. The beans can be sown with drill or corn planter, and the plants cultivated in the same manner as the corn crop.
4. Harvesting and threshing the beans are still in the experimental stage, no methods as yet being fully satisfactory.
5. When sown with corn, a fine grade of silage or fodder is obtained, and the beans do not in any way seem to interfere with the corn.
6. Bacteria-laden nodules will develop on the roots of the soy bean plants the first year of sowing, if the plot upon which the soy beans are grown is inoculated with earth laden with the soy-bean bacteria previous to planting.
7. Nearly all farm animals eat soy beans readily as a grain or forage and do well upon them.

Alfalfa.—In 1903, an experiment was commenced, to determine the value of alfalfa as a forage plant under varying conditions. The desire was to determine the best variety of alfalfa for Wisconsin, the amount of seed to sow per acre, the root development at different stages, the comparison of root development, and of yield with medium red clover, the

FIG. 60.—Comparison of the root development of alfalfa plants with a medium red clover plant. The plant on the right, alfalfa three years old; middle plant, alfalfa one year old; clover plant one year old on the left. Scale, one inch to the foot.

most desirable nurse crop to sow with alfalfa, and the best methods of cutting and curing the crop.

Sixteen plots, each containing one-twentieth of an acre, were sown to alfalfa, April 10th, on fall-plowed land. Three varieties of alfalfa seed were used, Turkestan, American, and Sand Lucern. The seed was sown at the rate of fifteen, twenty, twenty-five, thirty, and thirty-five pounds per acre, with oats as a nurse crop. A gentle southwest slope was selected in order to give the ground good drainage. The nurse crop was left to ripen and the barley harvested July 11th and the oats July 24th. On the plot where the barley was used as the nurse crop, the alfalfa started briskly after the barley was removed and reached the cutting stage on Sept. 10th. It was then mowed and gave a cutting of two and one-half tons of hay per acre, and ample growth was secured before freezing weather to give the desired winter protection.

On the plots where oats were used as the nurse crop, the alfalfa did not seem to rally as readily after the oat crop was removed, and no attempt was made to cut the alfalfa, the growth being left for winter protection.

The winter of 1903-1904 was noted for its severity, and the plots of alfalfa were exposed to the elements without a covering of snow during a large portion of the winter. Field inspections, made in the spring of 1904, showed the plants to be practically all alive and ready for growth on the approach of warm weather. The alfalfa on the plot from which the crop had been taken the previous autumn did not seem to start as readily as that on the other plots and it did not reach the cutting stage until 4 days after the alfalfa on the other plots.

During the fall of 1903, the American alfalfa and the Sand Lucern seemed to look much more vigorous than the Turkestan, and took on a dark green color while the Turkestan took on a yellowish hue and a portion of the leaves dropped.

Very little difference could be noted on the plots, the seed of which was sown at the rate of twenty and thirty-five pounds per acre, but that which was sown at the rate of fifteen pounds per acre, was somewhat too thin.

Two plots were given a top-dressing of finely-rotted manure in the winter, the effects of which were plainly noticeable during the season of 1904.

The plants grew vigorously and reached the cutting stage on June 6th (see fig. 61). The best stage for cutting alfalfa is when the plants are about one-fifth in bloom. If the weather should not be favorable when this period arrives, no serious harm will be done by waiting a few days. The first cutting was made at the stage given, and this was left to wilt during the day of cutting and a portion of the next, when it was raked and put into small cocks and covered with cotton duck caps (see fig. 62) to protect from rain, dew, and sunshine. The alfalfa was left to cure two days and then scattered out in the morning after the dew was off, and hauled to the barn in the afternoon. The second growth came on rapidly and was ready to cut July 12, thirty-six days after first cutting, (see fig. 63). The second cutting was harvested in a similar way to the first, and the third cut on August 12th, thirty-one days after second cutting (see fig. 64).

The plots were cut for the fourth time Sept. 16th (see figs. 65 and 66).

The field of clover that was used in comparison with the alfalfa, consists of one acre, and had been sown in the spring of 1903 with medium red clover at the rate of 12 pounds of seed per acre. The clover was cut twice during the season of 1904, and was handled, practically, in the same way as the alfalfa.

Moisture determinations of alfalfa and medium red clover, green and cured, compared with other grasses.

	Moisture content of green crop.	Dry matter in green crop.	Moisture content of hay.	Dry matter in hay.
Timothy	63.25	36.75	19.86	80.14
Brome grass	66.83	33.17	25.44	74.56
Clover (first crop)	74.92	25.08	15.13	84.87
Clover (second crop)	68.20	31.80	15.54	84.46
Clover (average)	71.56	28.44	15.33	84.67
Alfalfa (first crop)	72.57	27.43	14.59	85.41
Alfalfa (second crop)	72.92	27.08	17.36	82.64
Alfalfa (third crop)	71.11	28.89	15.82	84.18
Alfalfa (fourth crop)	71.95	28.05	23.22	76.78
Alfalfa (average)	72.14	27.86	17.74	82.26

FIG. 61.—Alfalfa plots June 6, just previous to cutting first crop.

FIG. 62.—First cutting of alfalfa June 6. Yield, 2 tons of hay per acre. Moisture content of hay, 14.59 per cent. Showing method of protecting the crop with cotton duck caps from rain, dew and sunshine.

FIG. 63.—Second cutting of alfalfa. July 12. Yield, 1.6 tons of hay per acre. Moisture content of hay, 15.89 per cent.

FIG. 64. Third cutting of alfalfa, Aug. 12. Yield, .88 tons of hay per acre. Moisture content of hay 15.70 per cent.

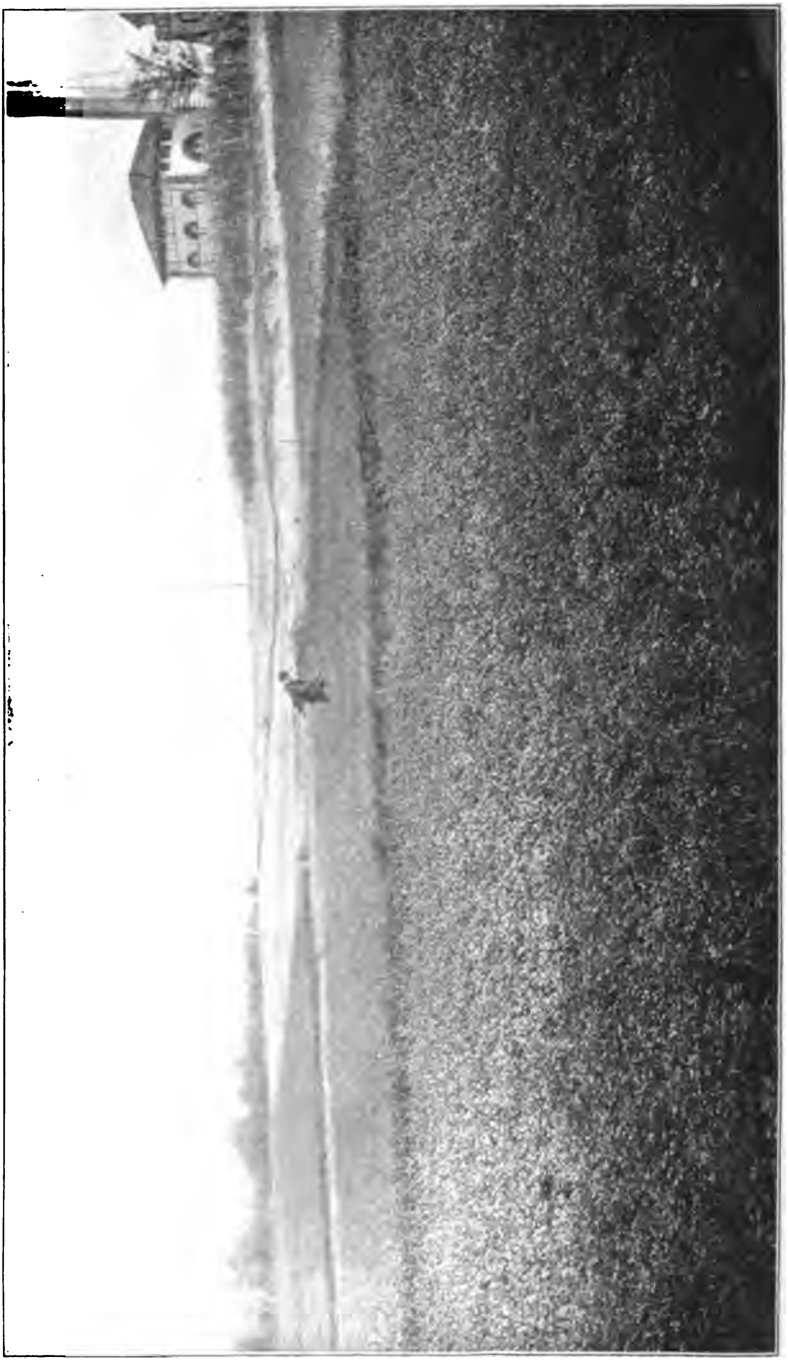


FIG. 65.—Alfalfa plots Sept. 16, previous to cutting fourth crop.

FIG. 66.—Fourth cutting of alfalfa, Sept. 16. Yield, .9 tons of hay per acre. Moisture content of hay, 15.64 per cent.

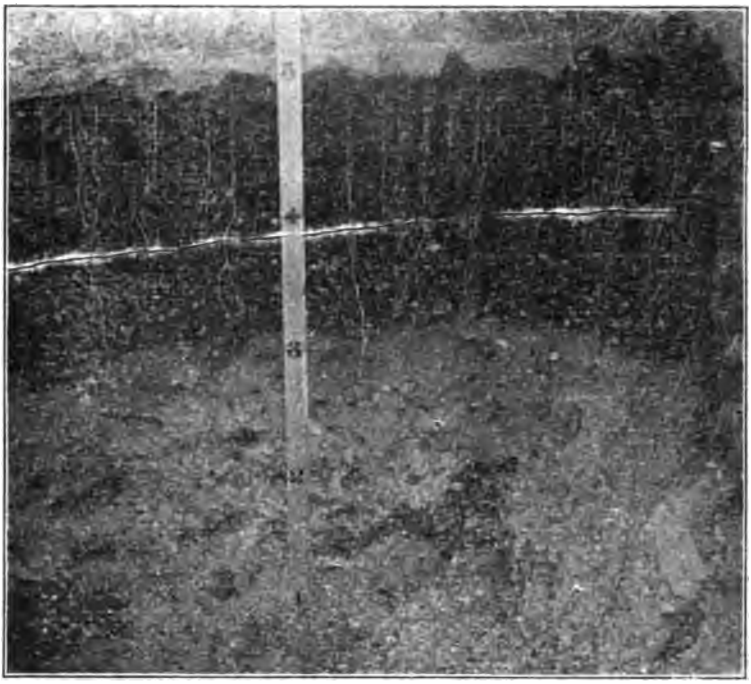


FIG. 67.—Showing root development of alfalfa plants three years old.

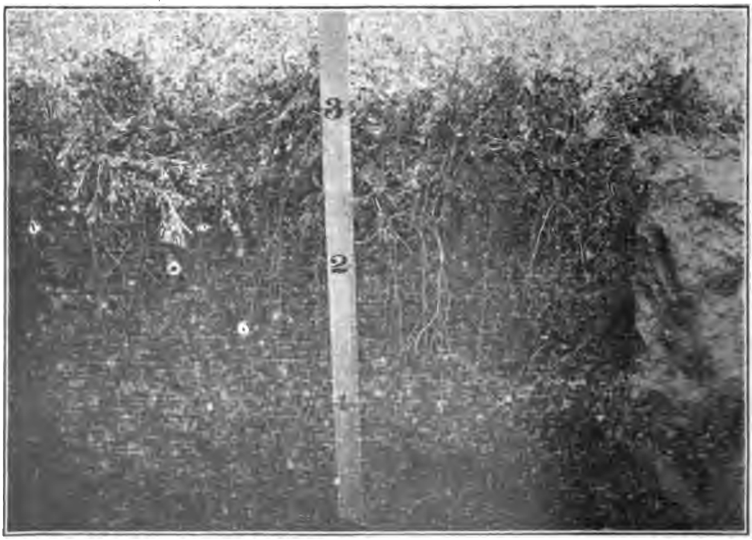


FIG. 68.—Showing root development of yearling alfalfa plants.

The amount of alfalfa hay procured per acre from the different varieties, did not differ widely. The American yielded 5.7, the Turkestan, 5.0 and the Sand Lucern, 5.6 tons per acre in all cuttings. The yield in regard to the amount of seed sown per acre was 5.3 tons from plots where seed was sown at the rate of fifteen pounds per acre, 5.5 tons where twenty pounds of seed were sown per acre, and 5.6 tons where thirty-five pounds of seed were used.

The plots that had a topdressing of manure, yielded 5.9 tons per acre, a slight advance over the plots similarly situated and seeded, that were not treated with a topdressing.

The plot that was sown with barley as a nurse crop at the same time as the other plots has given five cuttings since seeding, one the season of 1903 and four in 1904 which yielded 6 tons of hay per acre.

Root Development.—Alfalfa is noted for its wonderful root development, and is said to send down its roots into the soil to the depth of twenty feet and over. To note the root development on the experiment plots, an excavation was made beside a plot of alfalfa that had been seeded the spring of 1901. The main roots were found to penetrate the soil to the depth of five feet, and the rootlets went considerably beyond that distance (see fig. 67).. An excavation was also made in a plot of alfalfa, the seed of which was sown the spring of 1903, and roots were found to run down to the depth of three feet (see fig. 68).

The great root development of alfalfa enables it to withstand severe droughts and secure plant food and moisture several feet below the surface of the ground. Through the action of certain micro-organisms upon the roots of alfalfa, nodules are formed within which the bacteria live, that assist the plant to appropriate nitrogen from the air for its use in building plant tissue. The soil is also replenished with nitrogen by the decay of these vegetable organisms, and this nitrogen becomes readily available as food for successive plants. Soil does not always contain the alfalfa bacteria, and if not it becomes necessary to sow bacteria-laden soil on the field where it is the desire to sow the alfalfa seed. This soil must be

FIG. 69.—Farm crops nursery. Breeding grains and forage plants.

taken from an alfalfa field where plants, that have already developed the nodules, have been grown. Examination of alfalfa plants in twenty different counties of the state, during 1903–04, revealed the bacteria-laden nodules present in all alfalfa fields. From the fact that nodules were found on all plots where investigations were made, we are led to believe that the alfalfa plant, like the clover, develops nodules naturally in Wisconsin, and inoculation of the soil may not be necessary under our conditions.

A bulletin treating more fully on the growing and curing of alfalfa is now in preparation and will be available for farmers about March 1, 1905.

C. BREEDING GRAIN AND FORAGE PLANTS.

Plant breeding experiments have been carried on by our Experiment Station for three years past. The breeding has been largely by selection, and several new varieties of grain are being propagated especially for Wisconsin conditions. The breeding plots upon which the nursery beds are made are of various sizes according to the number of beds desired in the plot. The nursery beds are of two kinds, known as the foundation beds and centgener beds.

First Step in Breeding Grains.—The foundation beds are rectangular in shape and of sufficient size to hold approximately three thousand grain plants (see fig. 69). The seed grain used in the foundation beds has been selected with care the year previous from a general field of a good variety, or may be seed from any standard variety of grain. The planting is done with a machine so constructed that one seed will be dropped in a place, and the seeds four inches apart in the rows, and the same distance between the rows. If any seed fails to germinate, the space occupied is replanted with a seed of the same variety which is retained for that purpose.

Notes relating to general characteristics of the plants are recorded from time to time in the nursery record book, and plants that do not come up to the required standard are discarded. The plants occupying the outside rows are discarded,

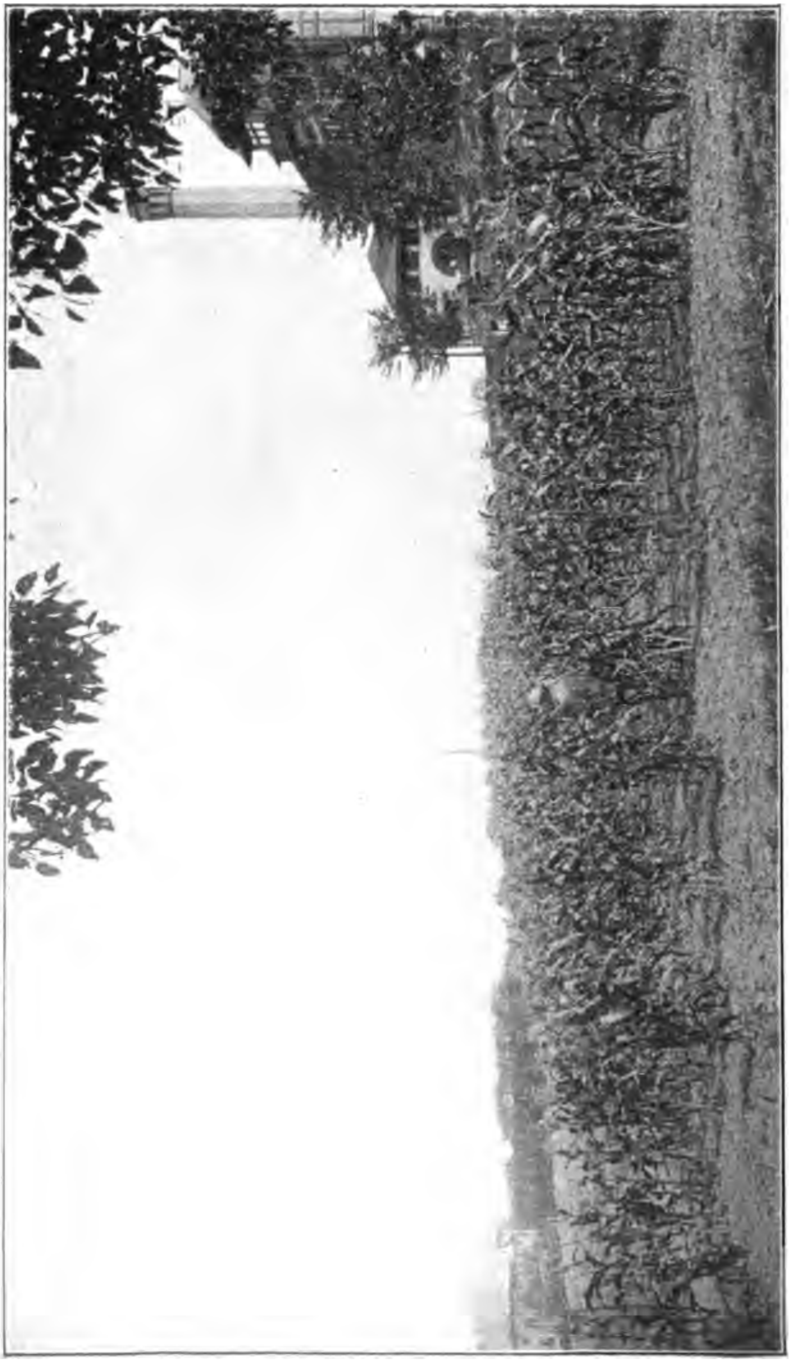


FIG. 70.—Corn breeding plot. An early maturing yellow dent variety which yielded 47 bushels of shelled corn per acre.

and only those within are taken into consideration when making comparisons for selection. Of the three thousand plants in the foundation bed, the grain of twenty of the best plants is selected by clipping the heads from the plants and placing them in envelopes arranged especially for that purpose. The remaining 2,980 plants are rejected and may be harvested for general purposes.

Second Step in Breeding.—The season following the planting of the grains in foundation beds, the grain retained and sealed in envelopes, is carefully weighed, and only the heaviest envelopes are selected. Usually the seeds in five or ten envelopes are retained for planting.

Each envelope retained contains the progeny of a single seed and is planted in a bed known as a centgener plot, a hundred seeds being planted therein, four inches apart. The five best plants are selected from each of the centgener plots, and replanted in centgener plots the following year.

Third Step in Breeding.—The progeny of five mother plants from each of the five centgener plots are planted as outlined above the third season, and the whole centgener plot retained as a unit and compared with other centgener plots planted to the same variety of grain. The same care is used in selection as previously noted.

Fourth Step in Breeding.—The seed grain retained from the best centgener plots is sown the fourth season on trial plots one-twentieth of an acre in size for comparison. The grain on the trial plots is sown, harvested, and threshed in accordance with the ordinary farm methods.

Fifth Step in Breeding.—The grain from the plots showing the greatest yield in the comparative test is retained and sown on acre plots the following season and then increased as rapidly as possible for dissemination.

Breeding Forage Plants.—Soy beans are being bred along similar lines except that more space is given them. The beans are planted twelve inches apart in order to give them sufficient room to develop properly.

Several choice varieties of grains and forage plants are being bred as above described, but as yet have not gone through

the complete process of breeding, consequently all pure-bred seed is retained for further testing.

D. TESTS WITH SEED CORN.

Minnesota No. 13 (Wis. No. 8).—Two hundred and seventy-seven members of the Experiment Association are co-operating with the Station in establishing standard varieties of corn for different sections of the state. The row system is used in all the tests. This system was outlined last spring and given to members of the Association who were willing to co-operate in testing corn. A similar test to that which is being carried on by the Experiment Association was made by the Experiment Station. For this test, ten ears of corn were selected of a yellow dent variety known as Minn. No. 13. The kernels of corn on the butts and tips of the ten ears were rejected on account of the lack of uniformity and the usual tardy germination of such kernels. The corn from each ear was then planted in hills, dropping three kernels in a hill as far as the seed would extend. Ten rows were planted from the corn on the ten ears, each ear representing a row. The corn was planted four feet apart in the row, and the same distance apart between the rows. The corn from the ear having the least amount of seed was planted in the first row and the same number of hills were planted in the other rows, the surplus corn being retained. The rows were numbered from 1 to 10, consecutively. Each row had 85 hills and the plot was 336 feet in length and 36 feet in width (see fig. 70). The corn was planted on a clay-loam soil, spring plowed, and first appeared above ground May 30. The ground was harrowed a short time after planting and was cultivated seven times during the growing period of the corn.

A careful study was made of the stalk and ear development during the period of growth and the results of these investigations, together with the percentage of stand and amount of smut present are herewith given.

The percentage of stand was determined by deducting one per cent for missing hills and one-half per cent for hills hav-

ing but one stalk, using 100 hills as a basis. The above method is employed largely by Illinois corn growers in making such determinations and seems to be very satisfactory.

Table of corn study.

NUMBER OF ROW.	Percentage of stand.	PER CENT. AFFECTED BY SMUT.		Number of suckers in row.	Number of stalks bearing one good ear.	Number of stalks bearing two good ears.	No. of stalks bearing one good ear and one or more nubbins.	Number of stalks bearing nubbins only.	Number of barren stalks in the row.	Total number of stalks in row.
		July 18th	Sept. 8th							
1	96.3	.4	5.4	15	146	16	35	3	1	201
2	96.3	1.4	6.7	13	132	17	35	8	1	193
3	94.2	3.5	13.4	32	123	12	43	8	2	188
4	95.7	2.7	20.6	8	157	0	19	16	6	198
5	97.3	4.6	24.7	80	154	2	17	14	7	194
6	97 9	3.2	28.1	68	183	6	35	4	2	230
7	71.5	2.4	16.1	46	88	4	23	9	0	124
8	82.1	8.6	41.5	60	92	10	20	8	17	147
9	97.3	1.7	8.9	38	134	18	38	7	5	202
10	96.8	.4	9.1	45	166	12	36	2	2	218
Av's and totals.	92.5	2.89	17.49	405	1,375	97	301	79	43	1,895

The corn showed early-maturing qualities and was fully ripened Sept. 23, with the exception of the lower portion of the plot, where the corn had lodged badly on account of the muddy condition of the soil. The stalks had been blown down in this portion of the field and the ears partially covered with mud, which prevented the ripening.

Each row was harvested separately by selecting the ears from the standing stalks. Well-developed ears were first selected that showed full maturity, and where but one ear grew on a single stalk. The nubbins and corn from stalks that grew more than one ear to the stalk were then selected, thus finishing the harvesting. The corn selected first was husked and separated into seed corn and feeding corn. The second selection was separated into marketable feeding corn and nubbins.

Table of yield per row, in the ear.

No. of row.	Seed corn. Lbs.	Marketable feeding corn. Lbs.	Nubbins. Lbs.	Total. Lbs.
1	10	77.0	9.0	96
2	22	70.0	9.0	101
3	36	45.5	7.5	89
4	24.5	62.0	6.5	93
5	50	41.5	5.5	97
6	30.5	51.5	6.5	88.5
7	8.5	50.0	5.0	63.5
8	29	41.0	7.5	77.5
9	16	59.0	6.5	81.5
10	34.5	82.0	12.5	129
Totals	261.0	579.5	75.5	916.0

Yield per acre 47 bushels, kiln dried corn (71 lbs. of ears to the bushel).

From the above table one finds that there was a wide variation in the progeny of the different ears in regard to quantity and quality. We also noted, through observation, that each row seemed to have characteristics peculiar to itself in regard to leaf and ear development.

It seems quite conclusive from the results obtained thus far, that by following the breeding of different varieties of corn by selection for a series of years, the best blood strains can be obtained and properly acclimated for the various sections of the state. Experiments will again be carried on the coming year on a more extensive scale.

Iowa Silver King (Wis. No. 7).—A field test was made in order to determine the cost of growing this corn per acre and to secure as much valuable seed as possible for further trials if the variety proved satisfactory. For this test an 18½ acre plot was used that had been plowed the previous fall at a depth of six inches. The tract of land planted was a portion of the University Hill Farm upon which a six-years' rotation is in practice. The farm referred to is one that was purchased by the University in 1898 and was in a run-down condition at that time, having been rented for several years previous and no effort made to keep up the fertility of the soil. The farm was divided into six separate fields and an alternating rotation started the season following the purchase of the farm. The rotation put in practice to improve the land was, first year, corn; second, oats with clover

and timothy seeding; third, clover; fourth, timothy; fifth and sixth, pasture. By following this rotation, each of the six divisions of the farm will be planted to corn every sixth year.

The plot used for corn had gone through the rotation during the past six years and was heavily manured the winter of 1902, excepting a small portion which had never before been cultivated. In the early spring, as soon as the land worked well, the ground was thoroughly disked, and dragged. This disking and dragging was continued at intervals until the corn was planted. The field was planted in accordance with the check-row system on May 23rd and 24th, with Iowa Silver King corn, an early white dent which had been purchased in the ear and selected for uniformity of kernels. Much care was used in order to get a uniform stand. The seed corn was tested and showed a germination of ninety-eight per cent. The planter plates were rimmed and fitted so that three kernels could be dropped eighty times out of a possible one hundred.

The second day after planting the ground was harrowed with a slant tooth harrow and this was repeated before the corn showed above ground. Twenty days after planting when the corn was approximately three inches high the cultivator was set to work and during the months of June and July, the plot of corn was cultivated four times, crosswise and lengthwise.

Tests made for uniformity of stand in accordance with the Illinois method showed an average of ninety-three per cent. The corn seemed somewhat backward at the beginning of the season on account of the cold wet weather, but as the season advanced it grew luxuriantly and was fully matured and ready for harvesting on October 3rd.

Before harvesting thirty bushels of choice seed corn were selected, while an opportunity was afforded of examining the stalk development before selecting the ears. This special seed corn will be used by the Station and Experiment Association in carrying on tests with this particular variety the coming year.

The corn was very free from smut, only 1.7 per cent developed, and this in some instances was scarcely noticeable. No difficulty was experienced in cutting and binding with the corn harvester.

An objectionable feature noticed in the growth of the corn was the tendency to sucker, but in picking the select seed ears no corn was taken from those stalks having suckers attached. By this means of selection the tendency to sucker will soon be eliminated. The corn was husked in the field and divided into three grades, viz., seed corn, marketable feeding corn, and soft corn and nubbins. Ears that were cylindrical, of the proper length and circumference, and uniform throughout, were selected for seed corn, and the feeding corn was that which remained after the soft corn and nubbins had been rejected. All feeding corn was sound, thoroughly matured and well fitted for the crib. The corn was measured by weight before taking to the crib, eighty-four pounds of ears being considered a bushel.

A yield of 72½ bushels per acre was secured which was divided in measurement as follows:

Yield of Silver King corn (Wisconsin No. 7).

Select seed corn.	Marketable feeding corn.	Soft corn and nubbins.
12 bushels.	48.5 bushels.	12 bushels.

In consequence of only a portion of the corn being husked at this writing (November 3,) an estimated yield was secured by selecting the corn grown on 2½ acres and using this as a basis for calculations. The following data will give a relative idea as to the kind and cost of labor performed and other items of expense in growing the field of Silver King corn:

Hand labor and team work.

1903.				
Oct	Plowing	12	days at $3.50	$42 00
1904.				
April and May.	Disking	12	days at 3.50	42 00
May and June.	Harrowing	4	days at 3.50	14 00
May.	Planting	2	days at 3.50	7 00
June and July.	Cultivating	23½	days at 3.50	82 25
Oct.	Harvesting	4	days at 3.50	14 00
Oct.	Shocking	20	days at 2.00	40 00
Total expense for labor				$241 25
Other items of expense:				
Three bushels seed corn at $2.50				$7 50
Binding twine (estimated)				10 00
Husking and cribbing corn (estimated) 8 cents per bushel				107 28
Total cost of growing, harvesting and cribbing 18½ acres of corn				$366 03
Cost of growing, harvesting and cribbing one acre				19 78
Approximate cost per bushel (72½ bushels per acre)				27 cts.

OAT AND BARLEY SMUT INVESTIGATIONS.

R. A. MOORE.

Oat smut investigations have been carried on by the Experiment Station during the past six years. Many former students, druggists, and farmers have co-operated with the writer in the crusade against grain smut. There is no longer a question but that oat smut can be readily and completely eradicated by the formaldehyde method of treatment and its use is recommended. The tests made this season were to determine how badly oats were affected with smut where the seed had been treated for its prevention under ordinary farm conditions, and the extent of damage that had been done by smut in fields of which the seed had not been treated. The number who had treated seed oats, or had purchased seed from others who had treated, was also determined and information concerning the treatment was given to farmers in general where tests were made.

The writer made tests in nineteen counties to determine the amount of smut present in oat fields, and reports were received from one hundred and four members of the Wisconsin Agricultural Experiment Association who made tests in twenty-nine counties and sent reports of their findings to the Experiment Station. From the investigations made by the writer in 201 fields where the seed had not been treated for the prevention of smut, 10.5 per cent of the oats were found to be affected with smut, and in seventy-nine fields where the seed oats had been treated, only .4 per cent, or a mere trace of smut was found. From the reports received from members

of the Wisconsin Agricultural Experiment Association, we are able to tabulate the following data:

Oat Smut.

Number of students reporting	104
Total number farmers asked	1,315
Farmers who had treated seed	313
Farmers who had not treated	1,002
Average per cent. of smut in treated	2.31%
Average per cent. of smut in untreated	7.04%

Barley Smut.

Number students reporting	40
Total number farmers asked	134
Farmers who had treated seed	14
Farmers who had not treated seed	120
Per cent. smut in treated seed	2.25%
Per cent. smut in untreated seed	6.08%

The investigations made during the past five years, show that the farmers of the state have quite generally adopted the oat smut treatment as recommended by the Experiment Station, and by so doing, the evil is rapidly being exterminated. Approximately one-fourth of the Wisconsin farmers in 1903 treated the seed oats for the prevention of smut, or purchased seed from parties who had treated. Approximately one-third of the farmers visited the past season used the oat smut remedy.

Method and Time of Making the Oat Smut Tests.—The best time to make the tests is when the oats are fully headed and on the verge of ripening. The oat plants coming from the seeds that were affected with smut are tardy on account of being diseased, and may not be far enough advanced to show smut if investigations are made too early.

When making tests for oat smut, use an ordinary barrel hoop, and on entering the field throw it over the oats in a manner so that oat plants will be encircled that were not previously selected by the operator. Count all stalks, whether smutted or not, within the hoop and then only those that are smutted. Divide the number representing the smutted heads decimally by the number representing the whole number of stalks which will give the per cent of smut present. If sixty stalks were encircled, and twenty of them were found to be smutted, we find that twenty divided decimally by sixty equals 33⅓, representing per cent of smut present.

Method of Treating Seed Oats for the Prevention of Smut.—The method that has proved to be the most effective during the past six years, and that now generally used by the farmers of the state, is the formaldehyde method. If the desire is to treat one hundred bushels of seed oats, purchase at least four pints of formaldehyde from your druggist, and make up the solution by pouring one pint of the formaldehyde into thirty-six gallons of water. Put the solution in barrels or in a tank and submerge the sacks of seed oats in the solution at least ten minutes. Raise the sacks of oats from the solution and let them drain for a minute or two, in order to save solution, and then empty on a threshing floor, platform, or on a canvas to dry. Do not spread out immediately, but let the oats remain in a heap for two hours after treating. If the wet sacks are spread over the pile of oats after treating it will prevent the rapid escape of the formaldehyde gas and make the treatment more effective. After the expiration of two or three hours the oats should be spread out and shoveled over at intervals, to facilitate drying.

Sowing the Treated Seed.—On account of the increased size of the oats after treating, it becomes necessary to set the seeder or drill to sow about one bushel per acre more than the ordinary amount of dry oats required. Oats can be sown with a force-feed seeder or drill one or two days after treating, without much difficulty. One pint of formaldehyde will treat, approximately, forty bushels of seed oats, but by having a goodly supply of the solution, and using four or five barrels or a large tank, the work is greatly facilitated, as five or six sacks of oats can then be treated every ten minutes.

The solution after being made up should be used immediately and not allowed to stand for several hours or days, as the gas is readily given off and the solution gradually becomes weaker. Bulletin No. 111, treating fully of oat smut investigations is available, and will be sent to farmers of Wisconsin on application to the Experiment Station.

Barley Smut.—Barley smut is gradually on the increase, and immediate steps should be taken for its eradication. From tests made by the writer in 176 barley fields in 19 coun-

ties, the barley showed on an average 4.5 per cent of smut. This means a serious loss to the farmers of this state, when we consider that they grow annually 13½ million bushels. On account of the fine grade of barley grown in Wisconsin, the demand is very great. The barley growers can not afford to have the good reputation of Wisconsin barley sacrificed, hence are advised by the Experiment Station to treat, with formaldehyde solution, all seed barley to be sown the coming season. The method recommended for the treatment of seed oats will eradicate barley smut, if the solution is made up by putting one pint of formaldehyde into twenty gallons of water instead of thirty-six, as recommended for oats. The barley hulls or the smut spores seem to be more resistant than those of the oats, hence we need a stronger solution for perfect treatment. Further experiments with barley smut will be made the coming year.

View of sugar beet field, 1904. Photograph taken shortly after thinning, on June 26. This field yielded at the rate of 25 tons of sugar beets and of over 3½ tons of sugar per acre.

TRIALS WITH SUGAR BEETS, 1904.

F. W. WOLL, R. A. MOORE AND A. L. STONE.

Experiments in sugar beet culture have been conducted at this Station every year since 1890 with the exception of the years 1893–96. Our earlier reports contain accounts of the results of each year's experiments, and a summary report of the work done in this line up to and including last year will be found in our twentieth annual report (pp. 293–301). The work done during the early part of this period furnished conclusive proof of the adaptability of the soil and the climate of our state to the culture of sugar beets and for this reason it has been deemed advisable during the past few years to continue the work only on a limited scale, the trials having been made in co-operation with the Bureau of Chemistry, U. S. Department of Agriculture, in their study of the influence of the environment on the sugar beet.

About two-fifths of an acre of land was set apart for sugar beet work in the spring of 1904, on a part of the same field on which sugar beets were grown last year. This part is known on our records as Sec. H, plots 7–13 inclusive; the crops grown on these plots during the seasons 1902 and 1903 will be seen from the following diagram.

	7	8	9	10	11	12	13
1902	..........Sugar beets..........			..............Oats.			Barley.
1903	Sugar beets.	..........................Soy beans......					Clover.
1904	..................................Sugar beets....................................						

It will be noticed that in this year's experiments, plot 7 grew sugar beets for the third season in succession, following peas in 1901; plots 8–12, inclusive, were in soy beans in 1903, and plot 13 in crimson clover. The field was plowed April 24, dragged twice each time on April 29 and 30, and a fine seed-bed prepared by discing and harrowing with a Tower pulverizer on May 20. The beets were planted the same day in drills eighteen inches apart with Kleinwanzleben beet seed, grown by E. H. Morrison, Fairfield, Wash., and on the eleven east rows, with seed kept over from last year (see XX Report, p. 298), at the rate of twenty pounds to the acre. Germination tests of the old and the new seed showed the former to have 160 per cent and the latter 107 per cent of viable seeds. Last year's seed came up somewhat later than the new seed did and showed more open spaces in the rows; on the whole both kinds gave, however, a quite uniform stand of vigorous plants.

The beets were kept clean from weeds during the growing period by wheel hand cultivator and hoe, the field being "laid by" on July 22. The beets were thinned on June 15th to approximately 8 inches apart in the row. The accompanying view of the beet field was taken shortly after thinning. The growth of the beets was very satisfactory during the early part

Meteorological table, Madison, 1904.

	May.	June.	July.	Aug.	Sept.	Total and averages.
Mean daily temp. °F	57.4	65.7	69.4	66.9	61.4	64.2
Normal mean temp. °F	58.2	67.8	73.0	70.3	62.4	66.3
Mean highest temp. °F	66.5	75.1	78.1	76.0	69.3	73.0
Mean lowest temp. °F	48.2	56.3	60.8	57.8	53.6	55.3
No. of heat units*	1779.4	1971.0	2151.4	2073.9	1842.0	9817.7
Normal heat units	1804.2	2034.0	2263.0	2179.3	1872.0	10152.5
Total precipitation, in.	5.03	2.85	3.27	3.20	5.93	20.28
Normal precipitation, in.	3.59	4.26	3.97	3.02	3.19	18.03
No. of rainy days	11	13	13	7	10	54
No. of clear days	10	12	8	6	10	46

* Mean daily temperature multiplied by the number of days in the month.

of the season, when both the moisture and temperature conditions were favorable. Abundant moisture was also supplied during the months of August and September, but a short intermediate period of hot sultry weather occurred in the early part of August which affected the beets injuriously, causing the

leaves to droop and the lower ones to turn yellow, as if some fungus disease had attacked the plants. During the latter part of the growing period many new leaves appeared and the plants seemed to take on new life. This condition, in all probability, accounts for the relatively low sugar content and the low purity of the beets during the early fall months, as shown by the results of the chemical analyses made during September and October (see below).

The sampling of the beets was commenced on Tuesday, September 20th, and continued the following Tuesdays until October 25th when the harvesting of the beets began.

The sugar contents of the samples of beets dug Sept. 20–Oct. 17 were as follows, 12.77 pr. ct., 12.64 pr. ct., 12.33 pr. ct., 13.48 pr ct., and 13.32 pr. ct., for samples 1–5, respectively. The estimated yields of beets per acre, obtained on basis of the weights of beets dug in 50 feet of an average inside row, ranged from 20.5 tons to 30.4 tons.

The results of the data obtained at harvesting time are given in the following table. The beets were harvested October 25 to 28, at which latter date they were placed in the root cellar of the University dairy barn. Each plot, 7–7a, 8–8a, etc., was 4 x 2 rods, or 1–20 of an acre, and they were separated by alleys, 4 ft. wide; 33 rows of beets were grown from new seed (plot 7–13, incl.), and 11 rows from old seed (plots 7a, 8a, 9a, etc.)

Results of data obtained at harvesting time, 1904.

Plot No.	Total wt. of beets on the plot.	Calculated yield per acre.	Sugar in beets.	Purity of juice.	Calculated sugar per acre.	Av. yield of beets per acre.	Av. yield of sugar per acre.
	Lbs.	Tons.	Per cent.	Per cent	Lbs.	Tons.	Lbs.
7	1,661	22.14	15.37	90.8	6,819	21.32	6,527
7a	471	18.84	14.97	92.0	5,652		
8	1,664	22.18	14.19	89.6	6,299	21.37	6,124
8a	473	18.92	14.81	88.7	5,600		
9	1,807.3	24.09	13.75	86.9	6,649	22.86	6,271
9a	479	19.16	13.44	86.9	5,135		
10	2,122.5	28.30	14.18	84.9	8,037	27.96	7,953
10a	673	26.92	14.32	89.1	7,699		
11	2,180.8	29.07	14.32	85.8	8,314	28.21	8,198
11a	640	25.60	15.29	87.2	7,849		
12	2,184.1	29.12	14.72	86.0	8,562	28.77	8,609
12a	692.5	27.70	15.77	89.5	8,753		
13	1,910.4	25.47	15.59	87.9	7,947	24.54	7,700
13a	544	21.76	16.03	89.9	6,961		
Alleys	1,827.9	25.13	14.44	84.5	7,235	....	....
Total	**19,345**	**25.04**	**14.63**	....	**7,340**	....	....

The tops of the beets harvested on the field were weighed and showed a total leaf production of 5,410 pounds, i. e., at the rate of 7 tons to the acre. Two-bushel samples of the unwashed beets were taken from each plot at harvest time. The samples were weighed before and after washing, and a loss of 6 per cent in the weight obtained, due to adhering dirt.

We note that the average estimated yield of beets per acre ranged for the different plots from 21.32 tons (plot No. 7) to 28.77 tons (plot No. 12), and that of sugar per acre from 6124 pounds (plot No. 8) to 8609 pounds (plot No. 12).

Comparing the data obtained for the beets grown from the two kinds of seed, we note that the new seed yielded, on the average, at the rate of 25.79 tons and 7,518 pounds sugar to the acre, while the 1903 seed yielded at the rate of 22.70 tons of beets and 6,807 pounds of sugar. The average per cent of sugar in the beets from the former seed was, therefore, 14.6 per cent, and in the beets grown from the old seed 15.0 per cent. The average yield of beets grown from the latter seed last season was 26.36 tons and the average sugar content of the crop 11.8. This seed evidently grew richer beets during the past season than our new seed and contained over 3 per cent more sugar per one hundred pounds of beets than they did last year. On account of the lower germination of this seed than of the new, there were open spaces here and there in this part of the field and the estimated yield per acre fell short about three tons of that of the new seed. It will be conceded, however, that either of these yields are excellent and considerably above what can be expected with even the best of culture during a series of years. The average estimated yield of sugar beets grown at our University Farm during the past fourteen years, viz., 1890 to 1904, were 17.37 tons beets, 4,900 pounds of sugar, average per cent sugar in beets, 14.1. Yields of 12 tons of sugar beets per acre and of about 3,200 lbs. of sugar per acre are considered very good by sugar manufacturers, and we note that the average yields for a series of fourteen years which have been obtained in our sugar beet work at the University Farm exceed these figures by about 50 per cent.

If we compare the yields from the different plots in the field it is at once apparent that the productiveness of the field increases as we go northward. Plot 13 is somewhat higher ground than the rest of the field and has a slightly lighter soil, which facts no doubt account for the low yields from this plot compared with neighboring plots to the south. The differences in the yields on the different plots were due, it is believed, to a change in the character of the soil in different part of the field and not to differences of the fertilization of the crops, since plots 8 to 12, inclusive, grew soy beans last year and we find as great differences within these plots as between any on the field. No manure or artificial fertilizers have been applied on this land since in the fall of 1901.

The per cent of sugar in the beets grown on plot 7 was higher than for the following plots, and the yield of sugar per acre from this plot was somewhat greater than the two following plots. There was no difference in the growth of beets on the different plats during the progress of the season, which was apparent to the eye, and the beets on plot 7 which grew this crop for the third successive season were as good as on any part of the field. While the plan of growing sugar beets on the same land for several years in succession is generally warned against, and is not to be recommended, our results show that under favorable climatic conditions and on land in a high state of fertility, as strong and healthy beets may be grown this way as where there has been a change of the crops grown on the land during the successive seasons.

The remarkably high yields per acre of both beets and sugar obtained by us during the past season furnish additional evidence of the capability of Wisconsin soils for sugar beet culture. During the past three years the yields obtained on our University Farm have exceeded twenty-five tons to the acre and the yields of sugar have exceeded three tons to the acre.

Wisconsin has now apparently in earnest entered upon an era of sugar production; at the present date three sugar factories are

*Twentieth annual report, Wisconsin Experiment Station, page 297.

in operation within the borders of our state, viz., at Menomonee Falls, Janesville and Chippewa Falls, and a fourth factory, at Menominee, Mich., with a daily capacity of one thousand tons of beets, draws about three-fifths of its beets from Wisconsin farms. These four factories combined, when running at full capacity, as they bid fair to do in the near future, will handle over twenty-five hundred tons of beets per day during the season, and will turn out at least twenty-five thousand tons of sugar each year, nearly one-half the amount of sugar consumed in the state. There is no reason apparent why our state should not manufacture all the sugar consumed by the people within our borders, and more, and it seems quite probably that this end will be reached before very many years have passed.

FEEDING STUFF AND FERTILIZER INSPECTION IN WISCONSIN, 1904.

F. W. WOLL AND GEO. A. OLSON.

A. INSPECTION OF CONCENTRATED COMMERCIAL FEEDING STUFFS.

In accordance with the provisions of the Wisconsin feeding stuff law (Chap. 377, laws of 1901) fifty-one different brands of concentrated commercial feeding stuffs were licensed for sale in this state for the calendar year ending December 31st, 1904, by 34 different manufacturers or agents. The names of the different licensed brands, and the guarantees for protein and fat under which they were sold, with the names and addresses of the parties in whose names the licenses were issued, are shown in the following table.

Licensed commercial feeding stuffs, 1904.

	Name of Brand.	Manufacturer or Agent.	GUARANTEE. Protein	Fat.
	OIL MEALS.		Per ct.	Pr ct.
1	**Ground Oil Cake**	Wm. Goodrich & Co, Milwaukee	34.0	6.0
2	**Ground Oil Cake**	Minnesota Linseed Oil Co., Minneapolis	34.0	5.0
3	**Ground Linseed Cake, O. P**	Midland Linseed Co.., Minneapolis	32.5	5.5
4	**Oil Meal or Ground Oil Cake**	Northern Linseed Oil Co., Minneapolis	34.0	5.0
5	**Ground Linseed Cake**	American Linseed Oil Co, Minneapolis	34.0	5.0
6	**O. P. Ground Linseed Cake**	Daniels Linseed Co, Minneapolis	32.0	7.0
7	**O. P. Ground Oil Cake**	The Red Wing Linseed Mills, Red Wing, Minn	32.5	7.5
8	**Viscid Oil Meal**	Milwaukee Elevator Co, Milwaukee	31.0	7.5
9	**Cottonseed Meal**	The American Cotton Oil Co, Chicago	43.0	9.0

Licensed commercial feeding stuffs, 1904—Continued.

	Name of Brand.	Manufacturer or Agent.	Guarantee. Protein	Fat.
	GLUTEN FEEDS AND MEAL, CORN FEEDS, ETC.		Per ct	Pr ct.
10	**Cedar Rapids Gluten Feed**	Douglas & Co., Cedar Rapids, Ia.	26.5	3.5
11	**Buffalo Gluten Feed**	The Glucose Sugar Refining Co., Chicago	27.0	3.0
12	**Continental Gluten Feed**	Continental Cereal Co., Peoria, Ill.	35.0	12.5
13	**Chicago Gluten Meal**	The Glucose Sugar Refining Co., Chicago	37.0	2.5
14	**Germ Oil Meal**	The Glucose Sugar Refining Co., Chicago.	24.0	10 0
15	**Hominy Feed**	Deutsch & Sickert Co, Milwaukee	11.0	7.0
16	**Hominy Feed**	American Hominy Co., Indianapolis, Ind	10.34	7.2
	MIXED CORN AND OAT FEEDS.			
17	**Royal Oat Feed**	The Great Western Cereal Co., Chicago	7.6	2.8
18	**Excelsior Corn and Oat Feed**	The Great Western Cereal Co., Chicago	9.0	4.2
19	**Vim or X Oat Feed**	The American Cereal Co., Chic'go	7.5	2.75
20	**Quaker Dairy Feed**	The American Cereal Co., Chic'go	14.0	3.5
21	**Victor Corn and Oat or C Feed**	The American Cereal Co., Chic'go	9.0	4.0
22	**Imperial Corn and Oat Feed**	Deutsch & Sickert Co., Milwaukee	10.0	4.5
23	**Hominy Mixed Feed**	Peter Schmitz & Son, Milwaukee	9.05	5.66
24	**Blue Cross Corn and Oats Feed**	E. P. Doty, Janesville	7.8	3.2
	MISCELLANEOUS DAIRY FEEDS.			
25	**Martin's Calf Feed**	John C. Martin & Son, Mineral Point, Wis	26.0	12.0
26	**Blatchford's Calf Meal**	John W. Barwell, Waukegan, Ill	25.0	5.0
27	**Blatchford's Sugar and Flax Seed.**	John W. Barwell, Waukegan, Ill	28.25	11.25
28	**National Calf Food**	National Food Co., Fond du Lac.	19.25	6.0
29	**Molasses Grains**	E. P. Mueller, Milwaukee	20.5	2.5
30	**Ajax Flakes**	Chapin & Co., Milwaukee	33.0	11.0
	ANIMAL AND POULTRY FOODS.			
31	**Meat Meal**	Armour Fertilizer Works, Chicago	50.0	10.0
32	**Blood Meal**	Armour Fertilizer Works, Chicago.	85.0	.2
33	**Poultry Bone**	Armour Fertilizer Works, Chicago	24.0	5.0
34	**Old Gold Poultry Food**	L. L. Olds Seed Co., Clinton, Wis	13.5	6.5
35	**F. P. C. Chick Manna**	F. P. Cassel, Lansdale, Pa.; Wernich Seed Co., Milwaukee, Agents	14.0	4.75
36	**Globe Brand Poultry Food**	The Albert Dickinson Co., Chicago	9.5	3.0
37	**Crescent Brand Chick Food**	The Albert Dickinson Co., Chicago	9.5	3 0
38	**Blatchford's Poultry Meats**	John W. Barwell, Waukegan, Ill.	33.0	10.0
39	**Extra Quality Quick Meal Chick Feed**	Steinmesch & Co., St. Louis; Kneisler Bros., Milw'kee Agts.	12.6	3.1

Licensed commercial feeding stuffs, 1904—Continued..

	Name of Brand.	Manufacturer or Agent.	GUARANTEE.	
			Protein	Fat.
			Per ct.	Pr ct.
40	**Cypher's Chick Food**	Cypher's Incubator Co., Buffalo, N. Y.	10.47	3.31
41	**Cypher's Scratching Food.**	Cypher's Incubator Co, Buffalo N. Y	11.34	3.17
42	**Cypher's Laying Food**	Cypher's Incubator Co., Buffallo, N. Y	15.26	5.5
43	**Swift's Blood Meal**	Swift & Co., Chicago	87.0	......
44	**Swift's Beef Scraps**	Swift & Co., Chicago	60.0	8.0
45	**Swift's Digester Tankage**	Swift & Co., Chicago	60.0	8.0
46	**Swift's Poultry Bone**	Swift & Co., Chicago	25.0	5.0
47	**Chamberlain's Perfect Chick Feed**	Wernich Seed Co., Milwaukee	14.06	2.9
48	**Mrs. Pinkerton's Chick Food**	Wernich Seed Co., Milwaukee	14.5	2.2
49	**Pike's Chick Feed**	R. A. Pike & Co, Minneapolis	13.56	1.85
50	**Puritan Chick Food**	Puritan Poultry Farms & Mfg Co., Stamford, Conn.; Wernich Seed Co., Milwaukee, Agts	12.5	7.5
51	**Sun Brand Chick Starter**	The Albert Dickinson Co., Chicago	11.5	3.5

Samples of concentrated commercial feeding stuffs offered for sale in the feed stores in different parts of the state were taken throughout the year by representatives of this Station. The inspection of the feed stores and sampling of the feeding stuffs during the past year were made largely by Mr. Roy T. Harris, of Warrens, Wis.; the writer (W.) has had charge of the office and laboratory work connected with the feed inspection, while the chemical analyses of samples of feed collected have been made by Mr. Olson, assistant chemist.

The inspections were begun on Jan. 2d, 1904, and have been continued with intervals throughout the year up to the present time (October 15th). Four hundred and thirty-five feed dealers in 130 different towns and cities in the state were visited during the year, the stores in Milwaukee having been visited five times during the year so far, those in Madison and Janesville three times, and those in 16 other of the larger cities of the state were visited twice. One hundred and thirty-nine samples of concentrated feeding stuffs were collected in all, all of which have been analyzed in our chemical laboratory. In addition to these samples, 43 samples of feeding stuffs were

forwarded for examination direct to the Station, by farmers or dealers, which were also analyzed. The following table contains a summary of the number of concentrated feeds collected under our state feeding stuff law, or received from outside parties, up to October 15th, 1904.

List of samples of concentrated feeding stuffs collected or forwarded for examination, season 1904.

Name of Feeding Stuff.	Samples collected.	Samples forwarded for examination.	Total.
Oil meals or cotton-seed meal	21	5	26
Gluten meal or feed, hominy feeds	15	4	19
Licensed corn, or corn and oat feeds	13	5	18
Ground corn and oats (sold as pure)	26	....	26
Wheat bran	3	2	5
Wheat middlings or shorts	....	3	3
Other millers' or brewers' refuse feeds:			
Wheat	....	....	....
Corn	....	3	3
Oats	....	4	4
Barley	2	1	3
Buckwheat	....	1	1
Speltz	1	....	1
Miscellaneous licensed dairy feeds	11	....	11
Miscellaneous unlicensed feeding stuffs	20	15	35
Poultry or animal foods	27	....	27
Total	139	43	182

The detailed results of the analyses of the samples of licensed commercial feeding stuffs collected by us or furnished by the manufacturers during the present year, will be given in a forthcoming bulletin of this Station, which will also contain tables showing the analyses of a number of samples of different feeds coming under the feeding stuff law, that had not, from various reasons, been licensed for sale in this state, as well as analyses of feeds that are not subject to license under the law.

SUMMARY OF ANALYSES OF LICENSED FEEDS.

The following table gives a summary of the results of the chemical analyses of the samples of licensed feeding stuffs collected during the present year. The samples furnished by manufacturers in registering their various brands for license, are not, as a rule, included in this summary. The

reader is referred to the annual feeding stuff bulletin for information as to the origin of the samples analyzed, and for discussions as to the detailed results of these and other analyses made in the feed inspection work during the past season.

*Summary of analyses of licensed feeds, 1904.**

Name.	No. samples.	Moisture.	PROTEIN—Per ct.		FAT—Per ct.		Crude fiber.
			Guar.	Found	Guar.	Found	
		Per ct.					Per ct.
Oil meal:							
Wm. Goodrich & Co.	4	8.97	*34.0*	**32.28**	*6.0*	8.12	8.18
Minn. Linseed Oil Co.	3	9.60	*34.0*	34.63	*5.0*	8.10	8.10
Midland Linseed Co.	5	7.69	*32.5*	33.07	*5.5*	7.91	8.48
Northern Linseed Oil Co.	2	8.90	*34.0*	**32.50**	*5.0*	8.21	7.62
Am. Linseed Oil Co	3	8.23	*34.0*	33.52	*5.0*	7.59	8.91
Daniels Linseed Co.	3	9.92	*32.0*	31.58	*7.0*	7.58	8.98
Red Wing Linseed Mills.	1	7.33	*32.5*	**30.00**	*7.5*	7.73	7.70
Cotton seed meal	3	7.27	*43.0*	**41.58**	*9.0*	9.73	8.03
Gluten feed:							
Cedar Rapids	6	6.75	*26.5*	**23.08**	*3.5*	4.10	7.72
Buffalo	2	7.95	*27.0*	**24.66**	*3.0*	3.15	7.79
Continental	1	7.68	*35.0*	**32.31**	*12.5*	**11.14**	13.05
Germ oil meal	1	6.28	*24.0*	**21.50**	*10.0*	9.75	10.45
Hominy feed:							
Deutsch & Sickert Co.	3	8.45	*11.0*	**10.27**	*7.0*	7.43	4.49
Amer. Hominy Co.	2	7.38	*10.24*	**9.09**	*7.2*	7.68	4.79
Royal oat feed	1	5.48	*7.6*	**5.69**	*2.8*	2.36	28.93
Victor corn and oat feed	2	9.15	*9.0*	**7.90**	*4.0*	**2.19**	13.87
Vim oat feed	2	4.10	*7.5*	**6.82**	*2.75*	2.33	28.10
Excelsior corn and oat feed	3	7.62	*9.0*	**7.28**	*4.2*	4.59	16.82
Imperial corn and oat feed	3	7.93	*10.0*	**7.82**	*4.5*	5.03	12.51
Hominy mixed feed	2	7.56	*9.05*	9.04	*5.66*	5.95	11.29
Blue cross corn and oats feed	2	8.58	*7.80*	9.03	*3.2*	4.67	11.52
Martin's calf feed	2	7.38	*26.0*	**23.25**	*12.0*	**11.37**	7.30
Blatchford's calf meal	2	10.61	*25.0*	**22.28**	*5.0*	**4.04**	4.57
Blatchford's sugar and flax seed	3	9.73	*28.25*	**26.90**	*11.25*	10.99	5.89
National calf food	1	9.45	*19.25*	19.38	*6.0*	6.15	8.50
Molasses grains	3	9.50	*20.5*	**19.32**	*2.5*	2.62	11.11
Ajax flakes	2	7.50	*33.0*	**30.85**	*11.0*	**10.26**	12.45
Armour's meat meal	1	6.35	*50.0*	50.75	*10.0*	10.65	....
Armour's blood meal	1	10.55	*85.0*	**83.38**	*.2*	.45	....
Armour's poultry bone	1	7.75	*24.0*	26.56	*5.0*	**1.13**	....
Old gold poultry food	1	10.35	*14.5*	**11.25**	*6.5*	**2.90**	5.10
F. P. C. chick manna	2	9.15	*14.0*	**12.57**	*4.75*	4.98	2.15
Globe brand poultry food	1	11.55	*9.5*	10.95	*3.0*	3.43	4.18
Crescent brand chick food	1	10.08	*9.5*	9.91	*3.0*	2.78	4.10
Blatchford's poultry meats	1	7.30	*33.0*	**30.75**	*10.0*	**7.74**	6.78
Extra quality quick meal chick feed	2	7.59	*12.6*	**10.63**	*3.1*	**2.15**	2.88
Cypher's chick food	1	9.38	*10.47*	10.19	*3.31*	**2.15**	2.60
Cypher's scratching food	1	9.85	*11.34*	12.81	*3.17*	3.13	3.85
Cypher's laying food	1	12.05	*15.26*	16.63	*5.5*	**3.48**	5.30
Swift's blood meal	3	11.06	*87.0*	**81.17**	*3.0*	**.33**	....
Swift's beef scraps	2	6.65	*60.0*	65.44	*8.0*	10.09	....
Swift's digester tankage	1	5.30	*60.0*	**58.50**	*8.0*	13.73	....
Swift's poultry bone	1	6.68	*25.0*	24.81	*5.0*	**2.78**	....
Chamberlain's perfect chick feed	2	8.33	*14.06*	**10.34**	*2.9*	2.65	2.14
Mrs. Pinkerton's chick food	1	10.13	*14.5*	**13.38**	*2.2*	2.33	2.40
Pike's chick food	1	8.30	*13.56*	13.56	*1.85*	1.88	3.10
Puritan chick food	2	8.95	*12.5*	12.97	*7.55*	**4.87**	5.19
Sun brand chick starter	1	9.43	*11.50*	**10.81**	*3.50*	3.38	5.25

* Guarantees in italics; deficiencies of more than .63 per cent of protein and .5 per cent fat in heavy type.

A large number of deficiencies occurred during the past year in the guaranteed protein or fat contents of the feeds, especially the former. In the case of nine different brands, the samples analyzed contained, on the average, appreciably less protein and less fat than the manufacturer or dealer guaranteed the brands to contain under the provisions of the state feeding stuff law. In the case of 21 other brands, the collected samples came below guarantee in protein, and five came below guarantee in fat, on the average, so that deficiencies occurred in the guaranteed content of protein in the case of thirty different brands out of fifty-one licensed for sale in the state during the current year, and in the guaranteed fat content in the case of fourteen different brands, i. e., 59 and 27 per cent of the total number, respectively.

As a rule, the deficiencies rendered the feeds of a lower quality than the buyers had reason to expect from the guarantees of the manufacturers or dealers, and a fraud was therefore committed, although in most cases this was, perhaps, unintentional and came from a lack of close supervision with the chemical composition of the output of the factories, rather than from any intention to deceive the consumers. In other cases, as for instance, in the brands of the oil meals, a deficiency in protein was always accompanied by an excess of fat above the guarantee. In this case, the buyer was not necessarily the loser, since the feeding value of fat for some purposes is at least equal to that of protein, but feeds of this class are, as a general rule, purchased for the sake of supplementing farm-grown crops or more starchy mill feeds with protein, and the buyer has, at any rate, a right to obtain the feed which the guarantee of the dealer of the feed would suggest, and not one equally good.

The large number of deficiencies in the guaranteed composition of the licensed feeds sold in the state during the current year, suggests one or two conditions: *First,* the manufacturers or dealers doing business in this state, do not keep close watch of the chemical composition of the feeds put out by them, or *second,* the buyers do not pay much attention to

the chemical composition of the feeds which they buy, or both of these conditions may, and in all probability do, prevail.

An agreement should be made in purchasing licensed feeds, that the dealer or manufacturer is to make good any deficiency in the protein or fat contents below guarantee, that may be found. It would be a safe rule to go by in making such an agreement that protein and fat are, on the average, of equal value for feeding purposes, pound for pound, and that the price of one pound of either component, according to average Wisconsin conditions, may be placed at 2½ cents.* If a deficiency of, say 2 per cent in the guaranteed protein content occurs, the manufacturer should refund the buyer 2½ multiplied by 2, equal 5 cents for every hundred pounds of feed bought, or $1.00 per ton. Such a system of adjusting purchases is in vogue in European countries where concentrated feeds are largely sold on basis of their actual composition, as found by chemical analysis; the buyer then pays for what he gets and no more. The feed business in this country will doubtless in time be regulated by a similar system, but this will not be apt to come about until purchasers post themselves on the chemical composition of various feeding stuffs, and understand that the same feeds, even if entirely free from adulterations, may be subject to great variations in their contents of valuable components, and hence be of greatly varying value as feeds for farm stock.

ANALYSES OF MIXED CORN AND OAT FEEDS.

Special mention should be made of the mixed corn and oat feeds, of which eight different brands are licensed for sale in this state during the current year. It will be noted from the above table, that of these brands, all but two contained considerably less protein than the manufacturers' guarantees, the two exceptions being the Hominy Mixed Feed, and Blue Cross Corn and Oats Feed. In the case of one brand, Victor Corn and Oat Feed, marked deficiencies occurred in the guaranteed contents of both protein and fat. Feeds of this kind are sold

*Bulletin 106, page 44.

at a considerably higher price than their actual feeding value would warrant, presumably because many buyers still believe that they are "nearly as good" as pure, ground corn and oats. Their contents of valuable food components are, however, very low and they contain a high percentage of crude fiber, viz., from 12.5 to 28 per cent. Under these conditions it is doubly to be regretted that the manufacturers do not see to it that their feeds contain the guaranteed percentages of protein and fat. Farmers are urged, therefore, to exercise caution in making purchases of feeds of this class. It is, in general, a safer plan to buy standard guaranteed feeds, like pure corn and oats, flour-mill feeds, or by-products from oil mills, glucose factories, etc., since even at their best, most of the corn and oat refuse feeds referred to, contain such a low percentage of protein and high percent of crude fiber as to be worth much less for feeding farm stock than the price generally asked for them.

ANALYSES OF GROUND CORN AND OATS.

We shall here only refer to the results of the analyses of one more class of feeding stuffs, viz., ground corn and oats, reserving fuller mention of our results of this year's analyses for our next annual feed bulletin. The pure grains ground together are exempt from license under the state feeding stuff law, but in order to know whether feeds sold as *ground corn and oats, mixed feed, chopped feed, ground feed,* etc., are composed of nothing but pure grains, it is necessary to subject samples of feeds of this class found on the market to chemical analysis. During the past season, twenty-six samples of ground corn and oats were collected and analyzed, all of which were supposed to be composed of nothing but shelled corn and oats, ground together, and were sold as such. The results of the analyses of these samples are given below.

Analyses of ground corn and oats, 1904.

Lab'y No.	Name of manufacturer.	Name of dealer.	Moisture.	Protein.	Fat.	Crude fiber.	Nitrogen free extract.	Ash.	Price per ton.	Remarks.
			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.		
925	Milling Co., Alton	H. M. Johnston Lumber Co., Baraboo	15.58	8.75	1.60	8.13	64.29	1.65	$22 00	No. 1 feed, cob, musty
1024	D. Goldberg, Antigo	Manufacturer	12.25	8.81	3.35	4.60	69.19	1.80	23 00	
922	A. Timme & Son, Delton	Chas E Kachel, Baraboo	13.05	9.63	1.75	5.40	67.47	2.70	25 00	Musty.
1022	Milling Co., Grand Rapids	Branch Store, Wausau	10.43	10.19	3.98	5.35	67.80	2.25	23 00	
1023	John H. Ebeling, Green Bay	G. H. Goldrick, Aniwa	11.28	9.94	3.78	3.53	69.57	1.90	26 00	
1020	John H Ebeling, Green Bay	Edgar Hay & Grain Co., Edgar	10.38	9.69	3.25	3.90	70.68	2.10	25 00	
987	E. P. Doty, Janesville	David Brown, Janesville	10.20	10.25	5.15	4.65	67.00	2.75	25 00	
985	Robt. C. Wallace, La Crosse	Manufacturer	11.43	9.56	4.13	5.05	67.28	2.55	24 00	1:1.
984	A. Grams & Sons, La Crosse	Manufacturer	12.25	9.69	3.75	3.55	67.96	2.80	24 00	
986	Thomas & Phalon, North La Crosse	C. F Hanson, Onalaska	11.93	9.81	3.58	4.95	67.63	2.10	25 00	
921	B. M Minch, Madison	Manufacturer	14.80	10.00	.98	6.48	65.19	2.55	23 00	1:1; musty; from immature corn.
917	G. Maisch, Madison	Manufacturer	19.43	10.31	.90	3.50	63.38	2.48	25 00	Musty; from immature corn.
924	Wm. Hoffman, Middleton	S. M. Jacobs, Madison	12.90	10.25	4.40	3.18	66.39	2.88	23 50	Musty; has cob.
923	Roller Mills, New Richmond	Gross & Silber, Necedah	10.25	10.25	2.58	7.05	66.74	3.13	27 00	Very little corn.
919	Roller Mills, New Richmond	S. M. Jacobs, Madison	10.08	10.44	3.95	6.33	65.87	3.33	24 00	No 2 feed.
920	I. W. York, Portage	Manufacturer	13.65	9.50	1.80	4.93	67.39	2.73	24 00	1:1; musty.
942	R. P. Koenig, Watertown	Manufacturer	11.75	9.25	3.73	7.30	65.49	2.48	22 00	130:240.
941	Globe Milling Co., Watertown	Manufacturer	10.43	9.50	4.10	9.73	63.51	2.73	26 00	1:2.
1039	Globe Mill'g Co, Watertown	Manufacturer	11.00	9.69	3.85	6.20	66.73	2.53	23 00	
1040	Globe Mill'g Co., Watertown	Manufacturer	10.60	8.69	3.90	4.90	69.48	2.43	23 00	
1025	H. E. McEachron, Wausau	Comerford & Clark, Appleton	11.60	9.88	3.70	4.83	67.79	2.20	26 00	
1021	H. E. McEachron, Wausau	L. Steckbauer, Aniwa	12.23	9.88	3.30	4.90	67.44	2.25	25 00	
1053	H. E McEachron, Wausau	S M. Jacobs, Madison	12.83	10.88	3.30	5.13	65.56	2.30	25 50	
918	Diamond Elevator and Milling Co., Minneapolis	L. E. Gleason & Son, Camp Douglas	15.23	10.13	1.20	4.78	66.26	2.40	25 00	No. 2 feed; 1:1.
1026	Washburn, Crosby Co., Minneapolis	Lutz & Spanz, Edgar	11.70	10.50	4.30	3.70	67.70	2.10	27 00	
1041	J. G. Chick Milling Co. Rockford, Ill	Wm. Bothe & Son, Milwaukee	10.35	8.81	4.20	6.83	68.71	2.10	24 00	
	Average (26 samples)		12.21	9.78	3.25	5.34	66.99	2.43	$24 42	
	Average, 1902 (96 samples)		9.87	11.41	3.66	6.55	....	....	27 20	
	Average, 1903 (49 samples)		11.42	9.97	3.69	7.78	64.19	2.95	22 35	

Of the twenty-six samples analyzed during the past season, two samples are considered suspicious, from the fact that they contained more than 7 per cent of crude fiber, and one sample is apparently adulterated, having a crude-fiber content of more than 9 per cent.*

The analyses made this year are not as numerous as in previous years, but the results obtained so far would indicate a marked improvement in the character of the ground corn and oats sold in the state. While the suspicious and adulterated samples made up 59 per cent of those analyzed in 1902, and 51 per cent of those analyzed in 1903, only 12 per cent of the samples collected this year were either suspicious or, in all probability, adulterated. A number of other samples have been collected recently and the results of the analyses of these will be included in the forthcoming feed bulletin. It is to be hoped that the good showing of this year's results, as regards the quality of the ground corn and oats on the market in this state, will not again be changed by the introduction of goods of inferior quality as pure ground corn and oats.

PROVISIONS OF THE FEEDING STUFF LAW.

The Wisconsin feeding stuff law which is given in full at the close of this report, provides that the following concentrated feeding stuffs shall be subject to examination and license under the law:

Linseed meal.
Cottonseed meal.
Oil meals of all kinds.
Peameal.
Cocoanut meal.
Sucrene feed.
Hominy feed.
Rice meal.
Mixed feeds of all kinds (unless made up of foods not subject to license, when branded so as to show their true composition).
Gluten meal.
Gluten meal.
Maize feed.
Starch feed.
Sugar feed.
Cerealine feed.
Oat feed.
Corn and oat feed.
Ground beef.
Dried blood.
Fish scrap.
Poultry foods (except such composed exclusively of inorganic materials, like oyster shells, quartz grit, etc.)
Condimental stock foods (claimed to possess nutritive as well as medicinal properties).

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*See Bulletin 97 of this Station, p. 36; also Bull. 106, p. 36.

The law provides that all licensed goods must be sold under guarantee of their contents of protein and fat; if sold in bags the following information must be *plainly stenciled on each bag:*

The name of the feed and the number of net pounds thereof in the bag.

The name and address of the manufacturer, and

The guaranteed percentages of protein and fat.

If sold in bulk, a printed statement giving similar information must be furnished with each car or other amount sold, and a certified copy of this statement shall be supplied to purchasers upon request.

Application blanks for registering brands of concentrated feeding stuffs for sale in this state under the state feeding stuff law will be forwarded upon request. A license certificate will be issued on receipt of the blanks properly filled out, accompanied by the annual license fee of $25.00 for each feeding stuff bearing a distinguishing name, and a two-pound analysis sample of the brand to be licensed.

Manufacturers are asked to promptly inform the Station of any change in the guarantees for the protein and fat contents of licensed goods that it may be found necessary to make during the year, so that the guarantees may be correctely given on our books and in future publications.

All feed dealers handling goods that come under the provisions of the law should see to it that these are licensed for sale in this state and that the packages in which they are sold are plainly marked on the bags as described above. Dealers are liable under the law if they handle goods that are not licensed for sale in this state or are not put up in accordance with the provisions of the law, and they should not accept such goods. They are requested to report all delinquincies to the Director of this Station and to forward samples of feeds that are suspected of being adulterated or below grade, to the Station for examination. Description blanks and directions for taking samples will be furnished upon request and samples properly taken and forwarded to this Station will be examined or analyzed, if necessary, to the extent which the work on hand will permit, without expense to the party seeking the information.

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The Station reserves the right to publish all results thus obtained, with full information as to the history of the samples, in its bulletins and annual reports.

B. INSPECTION OF COMMERCIAL FERTILIZERS, 1904.

The following manufacturers have taken out a license for the sale of the brands of fertilizers given, in this state during the current year, in accordance with Wisconsin statutes of 1898, sec. 1494c.

Licensed commercial fertilizers, 1904.

No.	Name of brand.	Manufacturer.	Guarantee, per cent. Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Total	Potash.
1	**Superphosphate**	Swift & Co., Chicago....	1.65	8.0	12.0	2.0
2	**Raw Bone Meal**	Swift & Co., Chicago ..	3.75	....	23.0	......
3	**Champion Wheat and Corn Grower**	Swift & Co., Chicago....	1.64	12.0	13.0	2.0
	Onion, Potato and Tobacco Fertilizer	Swift & Co., Chicago....	1.64	8.0	11.0	7.0
5	**Boar's Head Brand Potash Phosphate**............	The Packers Fertilizer Asso'n, Chicago	......	10.0	12.0	4.0
6	**Boar's Head Brand World of Good Superphosphate**.	The Packers Fertilizer Asso'n, Chicago	2.05	8.0	10.0	1.5
7	**Homestead Potato and Tobacco Special**	Michigan Carbon Works. Chicago	2.06	8.0	9.0	5.0
8	**Homestead, A Bone Black.**	Michigan Carbon Works, Chicago.......	2.05	8.0	9.0	1.5
9	**All Soluble**	The Armour Fertilizer Works, Chicago.......	2.88	8.0	10.0	4.0
10	**Phosphate and Potash**	The Armour Fertilizer Works, Chicago.... ...	......	10.0	12.0	2.0
11	**Bone Meal**...................	The Armour Fertilizer Works, Chicago.......	2.47	....	24.0	......
12	**Ammoniated Bone with Potash**	The Armour Fertilizer Works. Chicago.......	2.47	6.0	8.0	2.0
13	**Grain Grower**...............	The Armour Fertilizer Works, Chicago......	1.65	8.0	10.0	2.0
14	**Darling's Tobacco Special**.	Darling & Co., Chicago.	3.29	7.0	9.0	7.0
15	**Darling's Chicago Brand** ..	Darling & Co , Chicago.	1.65	8.0	10.0	2.0
16	**Currie's Garden and Lawn Fertilizer**..................	Currie Bros., Milwaukee	5.13	3.28	12.70	7.88
17	**Milwaukee Tallow and Grease Co.'s Bone Meal**..	Milwaukee Tallow and Grease Co., Milwaukee	4.05	....	22.0	......
18	**Swift's Bone Meal**..........	Swift & Co., Chicago....	2.50	....	25.0	3.0

Analyses of licensed commercial fertilizers, 1904.

Station No.	NAME OF BRAND.	Moisture.	NITROGEN.		PHOSPHORIC ACID.						POTASH.		Soluble nitrogen.
			Guaranteed.	Found.	Soluble.	Reverted.	Available. Guaranteed.	Available. Found.	Total. Guaranteed.	Total. Found.	Guaranteed.	Found.	
		Per ct.	Per ct.	Per ct.	Per ct	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1	Superphosphate	11.28	*1.64*	2.24	5.98	4.09	*8.0*	10.07	*12.0*	12.82	*2.0*	2.05	1.13
2	Raw Bone Meal	4.68	*3.75*	4.15	......	......	......	......	*23.0*	25.71	......	......	......
3	Champion Wheat and Corn Grower	5.83	*1.64*	1.62	1.28	13.43	*12.0*	14.71	*13.0*	15.67	*2.0*	2.23	.68
4	Onion, Potato and Tobacco Fertilizer	6.48	*1.64*	1.50	5.56	3.96	*8.0*	9.52	*11.0*	12.56	*7.0*	8.20	.15
5	Boar's Head Brand Potash Phosphate	7.75	......	......	8.19	3.68	*10.0*	11.87	*12.0*	12.80	*4.0*	5.13	......
6	Boar's Head Brand World of Good Superphosphate	6.51	*2.05*	2.06	8.00	.93	*8.0*	8.93	*10.0*	11.53	*1.5*	1.42	.40
7	Homestead Potato and Tobacco Special	13.08	*2.06*	2.76	5.28	3.46	*8.0*	9.06	*9.0*	12.12	*3.0*	3.69	.73
8	Homestead, A Bone Black	11.28	*2.06*	2.27	5.83	2.32	*8.0*	8.15	*9.0*	13.11	*1.5*	3.89	.17
9	All Soluble	4.63	*2.88*	2.71	4.10	4.90	*8.0*	9.00	*10.0*	11.53	*4.0*	4.25	.34
10	Phosphate and Potash	8.73	......	......	7.12	2.39	......	9.51	*10.0*	9.99	*2.0*	1.87	......
11	Bone Meal	4.90	*2.47*	4.10	......	......	......	......	*24.0*	24.58	......	......	......
12	Ammoniated Bone with Potash	7.84	*2.47*	2.10	4.76	2.79	*6.0*	7.55	*8.0*	10.0	*2.0*	2.50	.11
13	Grain Grower	3.85	*1.64*	1.99	7.47	4.73	*8.0*	12.20	*10.0*	13.36	*2.0*	3.08	.20
14	Darling's Tobacco Special	5.00	*3.29*	3.36	4.68	2.64	*7.0*	7.32	*9.0*	11.91	*7.0*	7.89	.78
15	Darling's Chicago Brand	5.95	*1.65*	1.82	4.44	4.10	*8.0*	8.54	*10.0*	10.57	*2.0*	2.11	.37
16	Currie's Garden and Lawn Fertilizer	2.00	*5.13*	5.13	.50	2.78	*3.28*	3.28	*12.7*	12.70	*7.88*	7.88	3.05
17	Milwaukee Tallow and Grease Co.'s Bone Meal	5.00	*4.05*	4.20	......	......	......	......	*22.0*	22.26	......	......	......
18	Swift's Bone Meal	4.95	*2.50*	2.71	......	......	......	......	*25.0*	**24.00**	*3.0*	**.92**	......

The Station analyses of the brands given are shown in the preceding table. According to the state fertilizer law, each manufacturer "shall affix to every package of fertilizer sold . . . a statement of the following fertilizing constituents, namely: The percentage of nitrogen in an available form, of potash soluble in water, and of available phosphoric acid, soluble and reverted, as well as total phosphoric acid." The guaranteed composition of the licensed fertilizers is given in the table in italics in connection with the results of our analyses of the samples furnished by the manufacturers in compliance with the law. The results are given in heavy type where a deficiency of a quarter of a per cent or more was found.

The mechanical analysis of the samples of bone meal included among the licensed brands of fertilizers gave the following results, the portion passing through a sieve of one-fiftieth inch mesh being designated as *fine-ground,* and that remaining on such a sieve as *coarse.*

Mechanical analyses of bone meal.

Station No.	Brand.	Fine ground	Coarse.
		Per ct.	Per ct.
2	Swift's Raw Bone Meal	39	61
11	Armour's Bone Meal	59	41
17	Milwaukee Tallow and Grease Co.'s Bone Meal	89	11
18	Swift's Bone Meal	52	48

FERTILIZER INSPECTION.

It is impossible to tell from the appearance or the odor of a commercial fertilizer whether it contains a large amount of valuable fertilizing ingredients or only a very small amount. There is, therefore, a strong temptation for irresponsible parties to make and sell inferior or even worthless goods as standard fertilizing articles; so much so, that it has been found necessary in all states where the fertilizer business has grown to be of any importance, that the state should in some way supervise their sale. Laws regulating the sale of commercial

fertilizers are at present in force in nearly all the states of the Union. The Wisconsin fertilizer law which was passed by the legislature of 1895, is given in full at the end of this report. According to the provisions of the law, all commercial fertilizers sold in this state at a cost exceeding $10.00 per ton, are to be licensed for sale. They must be sold on a guarantee of their contents of valuable fertilizing ingredients, and the director of the experiment station, on whom is laid the duty of enforcing the law, is authorized, in person or by deputy, to take samples of all commercial fertilizers sold in this state which come within the scope of the law. In case of licensed fertilizers it may thus be ascertained whether these come up to the guaranteed composition, and when it is found that parties are selling fertilizers without complying with the provisions of the law, the offenders may be brought before the proper legal authorities and convicted according to section 1494d of Wisconsin statutes of 1898. This section imposes a fine of $100.00 for the first offense and $200.00 for each subsequent offense. The analyses of the samples of fertilizers collected by us during this year have not been completed at this date; they will be published in a special bulletin in the spring.

It is hoped that all dealers in commercial fertilizers in the state will comply with the fertilizer law in all particulars, and that they, as well as purchasers of such fertilizers, will assist in the enforcement of the law by giving notice of violations of the same that may come to their knowledge. A strict compliance with the law is for the best interests of all honest dealers and consumers alike. Only firms that live up to the requirements of the law, and have taken out licenses for the sale of their brands of fertilizers should be patronized; the law does not offer purchasers any protection against dealers in other states who sell inferior or fraudulent goods.

MISCELLANEOUS CHEMICAL WORK.

F. W. WOLL, GEO. A. OLSON AND J. C. BROWN.

The work of the chemical department during the past year has, in the main, laid in two directions, viz., analyses made in connection with investigations conducted by this or other departments of the Station, and analyses of feeding stuffs and commercial fertilizers under the feeding stuff and fertilizer inspection laws of this State. Accounts of the work done by us in these lines will be found in the preceding pages of this report and in bulletins published during the year. In addition, a considerable amount of miscellaneous chemical work has been done, mostly for private parties who applied for information of special importance to them. We are always ready to do work of this character when it is possible with the limited help in our chemical laboratory, provided the subject of the inquiry is of more than mere personal interest, but, for the reason stated, often have to refer such parties to private commercial chemists. A brief statement of the main results obtained in analytical work of this character during the past year is given in the following pages, preceded by a description of the solutions and tables used in our laboratory in the Kjeldahl method of determination of nitrogen.

A. SOLUTIONS AND TABLES USED IN THE DETERMINATION OF NITROGEN BY THE KJELDAHL METHOD.

The following method of procedure for the determination of nitrogen by the Kjeldahl method worked out by Geo. A. Olson, Assistant Chemist, has been adopted in our chemical laboratory and has been found to greatly facilitate this im-

portant part of our chemical work. The percent of nitrogen in the substance is obtained by weighing out one gram of material and making the acid and the alkali solutions of such a strength that each c. c. of the acid solution corresponds to one percent of nitrogen, and that 10 c. c. of ammonia solution corresponds to 1 c. c. of acid. An acid solution of this strength will contain 34.398 grams of sulfuric acid per liter and is practically a seven-tenths normal solution, while the ammonia is practically a seven-hundredths normal solution.

By adjusting the two solutions in this manner and making the ammonia weaker than recommended by the Association of Official Agricultural Chemists, the accuracy of the nitrogen determinations is increased and the results are read off directly without necessitating any calculations.

The tables given below have been constructed for the conversion of percent of nitrogen into percent protein and ammonia. Their use will be easily understood from the example given. The table is calculated on the basis of 14.04 as the atomic weight of nitrogen, and 6.25 as the protein factor.

Example: One gram of material was weighed out. 3 c. c. of 0.7 normal acid was measured into the receiving flask and the excess of acid titrated back with 2.10 c. c. of .07 normal ammonia. This amount is equivalent to .21 c. c. of the acid solution. 3.00—.21 equals 2.79 c. c. of acid, or the nitrogen content of the substance is 2.79 per cent.

To find the corresponding per cent of protein, the nearest figure in the nitrogen column in part I of the table is taken, in this case 2.72, which equals 17 per cent of protein. The remaining .07 per cent of nitrogen, equivalent to .44 per cent. of protein is obtained in part II of the table. Adding this amount to 17 per cent gives 17.44 per cent of protein. Per cent nitrogen is converted into per cent ammonia in the same way; 2.79 per cent of nitrogen thus equals 3.30 + .09, or 3.39 per cent of ammonia.

Per cent of protein and ammonia corresponding to percentages of nitrogen.

I.									II.		
Per ct. N.	Pr. ct. Protein	Pr. ct. NH_3.	Per ct. N.	Pr. ct Protein	Pr. ct. NH_3.	Pr. ct. N.	Pr. ct Protein	Pr. ct. NH_3.	Pr ct. N.	Pr. ct. Protein	Pr. ct. NH_3.
.16 =	1. =	.19	5.60 =	35. =	6.81	11.04 =	69. =	13.42	.01 =	.06 =	.01
.32 =	2. =	.39	5.76 =	36. =	7.00	11.20 =	70. =	13.62	.02 =	.13 =	.02
.48 =	3. =	.58	5.92 =	37. =	7.19	11.36 =	71. =	13.81	.03 =	.19 =	.04
.64 =	4. =	.78	6.08 =	38. =	7.39	11.52 =	72. =	14.01	.04 =	.25 =	.05
.80 =	5. =	.97	6.24 =	39. =	7.58	11.68 =	73. =	14.20	.05 =	.31 =	.06
.96 =	6. =	1.17	6.40 =	40. =	7.78	11.84 =	74. =	14.40	.06 =	.38 =	.07
1.12 =	7. =	1.36	6.56 =	41. =	7.97	12.00 =	75. =	14.59	.07 =	.44 =	.09
1.28 =	8. =	1.56	6.72 =	42. =	8.17	12.16 =	76. =	14.79	.08 =	.50 =	.10
1.44 =	9. =	1.75	6.88 =	43. =	8.36	12.32 =	77. =	14.98	.09 =	.56 =	.11
1.60 =	10. =	1.94	7.04 =	44. =	8.55	12.48 =	78. =	15.17	.10 =	.63 =	.12
1.76 =	11. =	2.14	7.20 =	45. =	8.75	12.64 =	79. =	15.37	.11 =	.69 =	.13
1.92 =	12. =	2.33	7.36 =	46. =	8.94	12.80 =	80. =	15.56	.12 =	.75 =	.15
2.08 =	13. =	2.53	7.52 =	47. =	9.14	12.96 =	81. =	15.76	.13 =	.81 =	.16
2.24 =	14. =	2.72	7.68 =	48. =	9.33	13.12 =	82. =	15.95	.14 =	.88 =	.17
2.40 =	15. =	2.92	7.84 =	49. =	9.53	13.28 =	83. =	16.15	.15 =	.94 =	.18
2.56 =	16. =	3.11	8.00 =	50. =	9.72	13.44 =	84. =	16.34			
2.72 =	17. =	3.30	8.16 =	51. =	9.92	13.60 =	85. =	16.54			
2.88 =	18. =	3.50	8.32 =	52. =	10.11	13.76 =	86. =	16.73			
3.04 =	19. =	3.69	8.48 =	53. =	10.31	13.92 =	87. =	16.92			
3.20 =	20. =	3.89	8.64 =	54. =	10.51	14.08 =	88. =	17.12			
3.36 =	21. =	4.08	8.80 =	55. =	10.70	14.24 =	89. =	17.31			
3.52 =	22. =	4.28	8.96 =	56. =	10.90	14.40 =	90. =	17.51			
3.68 =	23. =	4.47	9.12 =	57. =	11.09	14.56 =	91. =	17.70			
3.84 =	24. =	4.67	9.28 =	58. =	11.29	14.72 =	92. =	17.90			
4.00 =	25. =	4.86	9.44 =	59. =	11.48	14.88 =	93. =	18.09			
4.16 =	26. =	5.06	9.60 =	60. =	11.68	15.04 =	94. =	18.28			
4.32 =	27. =	5.25	9.76 =	61. =	11.87	15.20 =	95. =	18.48			
4.48 =	28. =	5.44	9.92 =	62. =	12.06	15.36 =	96. =	18.67			
4.64 =	29. =	5.64	10.08 =	63. =	12.26	15.52 =	97. =	18.87			
4.80 =	30. =	5.83	10.24 =	64. =	12.45	15.68 =	98. =	19.06			
4.96 =	31. =	6.03	10.40 =	65. =	12.65	15.84 =	99. =	19.26			
5.12 =	32. =	6.22	10.56 =	66. =	12.84	16.00 =	100. =	19.44			
5.28 =	33. =	6.42	10.72 =	67. =	13.04						
5.44 =	34. =	6.61	10.88 =	68. =	13.23						

B. ANALYSES OF VARIOUS AGRICULTURAL PRODUCTS.

a. *Analyses of various feeding stuffs.* Three samples of marsh hay, five samples of corn silage and samples of sorghum silage, pea vine silage and liquid brewery refuse, were analyzed since the last publication of work of this character done in our laboratory. The results of the analyses are shown below.

Analyses of various feeding stuffs.

No	Name.	Moisture.	Protein.	Fat.	Crude fiber	N. free extract.	Ash.	Forwarded by	Remarks.
	1. *Marsh hay.*	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.		
1.	Big blue stem	7.30	5.19	1.90	36.90	44.86	3.85	A. W. Streckenbach, Amberg.	Andropogon furcatus.
2.	Blue joint grass, flowering stage	9.60	5.44	2.50	40.80	36.28	5.38	Chas. H. Grote, Mauston.	Calamagrostis canadensis.
3.	Blue joint grass, late cut	8.20	4.51	2.48	41.25	39.06	4.50	Chas. H. Grote, Mauston.	Calamagrostis canadensis.
	2. *Silage.*								
4.	Corn silage, immature corn..................	71.46	2.58	.97	6.91	16.64	1.44	E E. Jones, Rockland.	Quite acid, good flavor.
5.	Corn silage, ripe corn..	64.43	2.58	1.25	8.39	22.04	1.31	E. E. Jones, Rockland.	Not clean flavor, from stone silo.
6.	Corn silage, frosted corn	68.83	2.69	1.27	6.33	19.71	1.17	E. E Jones, Rockland.	Good flavor, from center of stone silo.
7.	Corn silage, frosted corn	40.44	2.72	.94	6.65	17.93	1.32	E. E. Jones, Rockland.	Not clean flavor, from next to wall of stone silo
8.	Corn silage, frozen corn	67.08	3.09	1.33	7.48	19.63	1.40	E. E. Jones, Rockland.	Not clean flavor, from stave silo.
9.	Sorghum silage	81.94	1.34	.78	5.48	9.09	1.37	University farm.	
10.	Pea vine silage	67.37	3.59	1.29	8.64	15.35	3.73	Lange Canning Co., Eau Claire.	Total acidity, 2.02 per ct. (butyric acid).
11.	Liquid brewery refuse.	93.72	2.59	.37	.....	3.07	.25	Chas. Linse, La Crosse.	Alb. N., .398 pr ct., Amide N., .014 per cent.

The samples of marsh hay were forwarded for examination by two parties who wished to learn their chemical composition and feeding value as compared with hay or straw. Both kinds of grasses, Big Blue Stem and Blue Joint Grass, when cut early, cure into valuable hay that is greatly relished by stock. The results of the analyses of the first two samples would bear out this statement; all the samples are lower in protein and considerably higher in crude fiber than hay of our tame grasses, but compare favorably in composition with straw from the small grains. It is very likely that early cut marsh hay, similar to the samples analyzed by us, will have about the same value for feeding purposes, ton per ton, as the best kinds of straw.

The five samples of corn silage were analyzed for the purpose of ascertaining the comparative value of silage from immature, ripe and frosted corn. It is probable that all these samples dried out to some extent in transit so that the actual water content of the silage as taken out of the silo, would be

somewhat higher than the figures given. Abundant practical experience has been accumulated during the last few years to show that frosted or even frozen corn will make at least a fair quality of silage when water is put on to the corn as it goes into the silo, so that it is sufficiently moist and heavy to pack well in the silo.

The analysis of the liquid brewery refuse was made with a view of ascertaining its possible feeding value for dairy cows. The results of the analysis indicate that the liquid may be considered about three-fourths as valuable, weight for weight, as separator skim milk. As the dairy farmer forwarding this sample is conducting a sanitary milk farm, it was deemed advisable not to use this refuse as a food for the cows, on account of its liability to ferment and the danger of injuring the keeping quality of the milk, which might come from its use.

b. *Analyses of sugar beets.* The following analyses of sugar beets were made during the fall of 1904 at the request of the Dodge and Dane County Fair Associations, and of farmers in different localities. Sample 9 was grown on high land and sample 10 on low land. The comparatively low purity in both these samples is possibly accounted for by a partial drying out of the beets before the analyses were made. Farmers forwarding sugar beets to the Station for analysis should give the exact weight of the sample as shipped, so that corrections for loss in weight during transportation may be made.

Analyses of sugar beets.

No.	Sugar Beets from—	Av. weight of trimmed beets.	Sugar in beet.	Purity of juice.
		Lbs.	Per cent.	Per cent.
1.	No. 113, Dodge Co. Fair, 1904	1.0	15.32	88.9
2.	No. 150, Dodge Co. Fair, 1604	1.2	14.36	83.3
3.	No. 157, Dodge Co. Fair, 1904	1.2	15.68	80.0
4.	No. 489, Dodge Co. Fair, 1904	1.0	15.36	83.0
5.	No. 541, Dodge Co. Fair, 1904	2.2	11.70	78.7
6.	No. 101, Dane Co. Fair, 1904	1.8	12.24	83.7
7.	No. 189, Dane Co. Fair, 1904	1.6	11.28	84.9
8.	No. 203, Dane Co. Fair, 1904	3.8	8.04	75.6
9.	J. Fishnich, Middleton, Wis	1.5	15.00	76.8
10.	J. Fishnich, Middleton, Wis	3.7	13.84	78.8
11.	A. Lillich, Madisen, Wis	1.4	13.81	79.8
12.	F. W. Hanzlik, Chippewa Falls, Wis	1.4	16.72	82.8
13.	L. M. Newman, Chippewa Falls, Wis	1.2	15.37	84.8
14.	Woodruff Sugar Beet Co., Chippewa Falls, Wis	1.3	16.39	84.4
15.	Chas. Kops, Appleton, Wis	1.27	14.66	85.6
16.	Chas. Merkel, Appleton, Wis	1.44	15.79	85.0

c. *Analyses of limestone and shale.* Analyses of thirteen samples of limestone were made to determine their purity. Limestones from various parts of the state have been previously examined and have been found, with only a few exceptions, to be of dolomitic origin, i. e., composed of about a quarter or more of magnesium carbonate in addition to calcium carbonate. The analyses given below show limestones of this character, except No. 8 and No. 9 which were forwarded from Iola, Kansas. Sample No. 1 was forwarded by Wm. Larson & Co., Green Bay, Wis., Nos. 2 to 7, inclusive, by Green Stone & Quarrying Co., Sawyer, Wis., and Nos. 10 to 13 inclusive, by Menominee River Sugar Co., Menominee, Mich.

Analyses of lime stone.

	Calcium carbonate.	Magnesium carbonate.	Ferric oxid and alumina.	Silica.	Water.	Undetermined.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	55.067	42.189	0.800	1.700	0.030	0.214
2..........	77.190	16.786	0.300	5.370	0.354	....
3..........	87.157	11.730	0.050	0.780	0.283	....
4..........	75.369	22.674	0.130	1.390	0.437	....
5..........	81.977	15.240	0.080	2.250	0.453	....
6..........	60.900	37.158	0.100	2.060	0.000	....
7..........	78.584	19.797	0.050	1.430	0.139	....
8..........	95.710	2.058	0.850	1.148	0.046	0.190
9	96.360	1.240	0.130	2.100	0.050	0.120
10..........	38.376	....	....	....	....	....
11..........	37.830	....	....	....	....	....
12..........	39.150	....	....	....	....	....
13..........	39.151	....	....	....	....	....

Analyses of shale.

	Calcium carbonate.	Magnesium carbonate.	Ferric oxid.	Alumina.	Other bases.	Silica.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1	14.820	0.870	16.400	28.620	0.390	38.900
2..........	10.450	1.020	20.400	27.190	0.290	40.650

The pure limestones which have been analyzed are of the geological formation known as the Trenton series, which are chiefly found in peculiar layers (so-called "Glass Rock") in the lead region in the southwestern part of the state, "the most typical development being on the Platte and Fever Rivers and their tributaries and may be well seen near Platteville, Quimby's Mills and elsewhere.*"

*Geology of Wisconsin, Vol. 1, page 176.

Professor Whitney reported the composition of this stone as follows: Carbonate of lime, 97.92 per cent; carbonate of magnesium, 1.60 per cent; iron and magnesia, .28 per cent; insoluble residue, .82 per cent.

The quality of this stone found in our state is limited, and industries requiring a pure limestone, as the sugar beet factories, must therefore look for such elsewhere. Limestones of excellent quality have been found in northern Illinois and in Michigan, and the beet sugar factories within our state have, so far, obtained from these states the limestones required in the processes of defecation and carbonation in the manufacture of sugar from sugar beets.

Analyses of miscellaneous materials, in per cent.

	Moisture.	Ash.	Nitrogen.	Phosphoric acid.	Potash.		Forwarded by—
Fertilizing materials.							
Pea vine silage juice[1]	91.49	1.89	.46	.02	.34		Paul Lachmund, Sauk City.
Trevor sheep dung	18.00	......	3.92	1.36	1.90		A. H. Craig, Mukwonago, Wis.
Walter's phosphate[2]	......	......	......	17.85	......		U. S. Consul, Bremen, Ger.
	Water.	**Solids.**	**Fat.**	**Cas. and albumen**	**Ash.**		
Dairy products.							
Dry milk flakes	6.85	93.15	.88	30.63	8.35		The Dry Milk Co., N.Y. City
Dry cream flakes.....	2.87	97.13	17.69	27.63	7.15		The Dry Milk Co., N.Y. City
	Water.	**Insol. Mtr.**	**$CaSO_4$.**	**$CaCl_2$.**	**$MgSO_4$**	**NaCl.**	
Dairy Salt.							
1 N. Y. cheese salt.........	.04	.04	1.09	......	.11	98.72	Studley & Karlen, Monticello, Wis.
2 N. Y. cheese salt.	.45	.01	1.45	.60	.32	97.57	Studley & Karlen, Monticello, Wis.
3 Colonial Brick cheese salt	.06	.03	1.75	.56	.30	97.30	Studley & Karlen, Monticello, Wis.
4 Worchester cheese salt...	.23	.01	1.31	.42	.04	97.99	Studley & Karlen, Monticello, Wis.
5 Wyandotte cheese salt...	.18	.02	1.56	.81	.38	97.05	Studley & Karlen, Monticello, Wis.
6 Wyandotte cheese salt ...	.09	.03	1.45	.43	.17	97.83	Studley & Karlen, Monticello, Wis.

[1] Contained .58 per cent. lactic acid.

[2] Analyzed by Mr. A. Ystgard. Citrate-sol. P_2O_5, 12.79 per cent.. A sample of Thomas' phosphate analyzed contained 18.56 and 11.37 per cent of total and citrate-sol. P_2O_5, resp. (See *Country Gentleman*, Oct. 6, 1904).

d. *Analyses of miscellaneous materials.* Analyses were made of the juice of pea vine silage oozing out at the bottom

of a silo, of Trevor sheep dung, and of a new phosphatic fertilizer; furthermore, of two samples of desiccated milk manufactured by the Dry Milk Co., of New York City, and of a number of dairy salts. The results of these analyses are given in the preceding table.

Effect of addition of blue-pill tablets on lactometer readings. While studying at this Station last winter, Mr. A. Ystgard, at present assistant chemist to the Illinois Experiment Station, made comparative determinations of the specific gravity of milk with and without the addition of preservatives. The preservative used at the time in our dairy barn was the so-called blue-pill tablets, weighing, on an average, .695 gram each. A qualitative chemical analysis showed them to be composed of chrome alum. The determinations of specific gravity were made by Soxhlet's lactometer at 15.5 deg. C. and by Westphal balance. The average difference obtained in case of eight samples of milk was .0019 by the former and .0018 by the latter method, the specific gravity of the milk being increased to this extent by the addition of one tablet to 275 c. c. of milk, which is the approximate volume of the weekly composite samples as taken in our dairy barn.

DESCRIPTION OF THE LABORATORIES OF THE CHEMICAL AND BACTERIOLOGICAL DEPARTMENTS.

The chemical and bacteriological departments of the Experiment Station occupy the greater portion of the west half of the new Agricultural Building, the chemical laboratories being largely on the south side of the building, and the bacteriological on the north side. The laboratories are so arranged that all student work is done on the lower floors, and the research and control work of the Experiment Station on the upper floors.

A description of the new Agricultural Building by Director Henry was published in the Twentieth Annual Report of our Station (pp. 7–12), to which paper the interested reader is referred. The following descriptions of the quarters of the chemical and bacteriological departments furnish detailed information as to the equipment of these departments and their facilities for the work which they are called upon to do.

A. Laboratories of the Chemical Department.

F. W. WOLL.

The chemical department of the Station occupies the following rooms in the west half of our new agricultural building: In *the basement,* four laboratories, one office, two store rooms and one work room; on *first floor,* one office; on *second floor,* three laboratories, one office and one store room; on *third floor,* two laboratories and one office, making in all nine laboratories, four offices and three store rooms. The reproductions

of photographs and floor plans of the various rooms given in this report will convey a good idea of the facilities of our department for investigation and instruction. The description given below of the arrangement and the equipment of the various rooms is submitted as text to these illustrations in the hope that it will prove of interest and value to persons in other institutions who will have an opportunity to plan new quarters. The various laboratories will be described first and more fully than the other rooms, as the chief interest to the chemist centers in these.

Student laboratory (See Figs. 72 and 73). The laboratory for instruction in agricultural chemistry is located in the full-height basement of the building and is amply lighted by seven large windows to the south and two to the west. It has excellent accommodations for thirty students and by arranging two laboratory periods, double this number may be accommodated. As shown in the floor plan, there are six center tables, five of our standard laboratory tables and one (No. 4) used for general work, extractions, distillation, glass blowing, etc.

Description of our standard laboratory table. A cross-section of our standard table is shown in Fig. 74, and a photographic view in the foreground on Figs. 72 and 77. This table is 12½′ long, 4′ wide, and 38″ high. It is made of yellow pine with a 1″ hard maple top (made of 2½″ wide boards). All tables are stained with aniline black.*

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*The writer saw this fine finish for laboratory tables for the first time in the municipal laboratory of Copenhagen in 1891. During late years it has been generally adopted for laboratory purposes in this University and elsewhere. The directions for staining tables are as follows:

Two solutions are required:

Solution A.—125 grams of copper sulfate and 125 grams of potassium chlorate are dissolved in a liter of water by heating.

Solution B.—120 grams of aniline oil and 180 grams of concentrated hydrochloric acid are dissolved in a liter of water.

Two coats of Sol. A are applied, while hot, by means of a brush, the second coat being put on as soon as the first one is dry. Two coats of Sol. B are next applied and the table allowed to dry thoroughly. A coat of raw linseed oil is then applied with a cloth so as not to use too much oil. The black color is brought out by this treatment, or in the case of soft wood, even by the application of Sol. B. A thorough washing with hot soap suds and then water completes the treat-

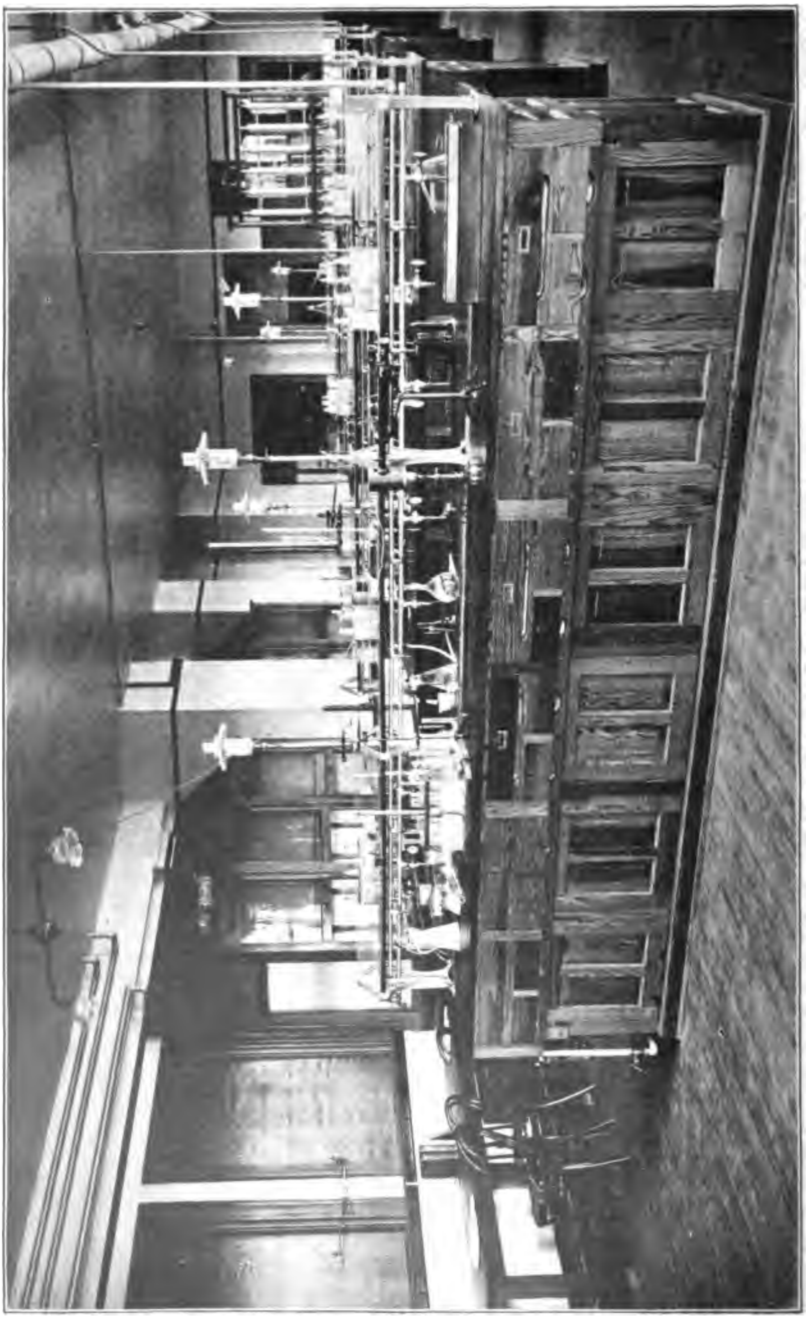

FIG. 72.—View of student laboratory.

It has six cupboards on either side provided with 8″ shelves and two tiers of drawers. The lower tier of 12 drawers alternate 14 and 24″ long and are 9″ wide, while the upper tier of six drawers are 18″ long and 20″ wide, all drawers being 3″ deep (inside dimension). The drawers project 4″ beyond the cupboards, and the top 1½″ beyond the drawers. The top is provided with a groove near the edge on the under side to prevent liquids that may be spilled on the table, from running down the side of the drawers and cupboards.

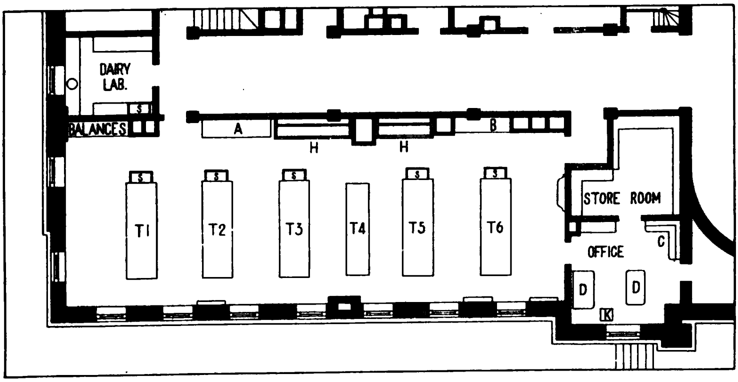

FIG. 73.—Plan of student and dairy laboratories. T1–T6 laboratory tables, H hoods, S sink, A reading table, B work table, C book shelves, D desks.

In the middle of the table is a trough, 3″ wide, and 1 to 3″ deep, lined with sheet lead, draining into the sink. The sinks are of alberene stone in all laboratories, and on the standard tables are 38 x 20 x 8″ deep (outside dimensions). Above the center trough directly under the shelf, the water and gas pipes are run, being supported by iron stands cast in the foundry of King & Walker Co., Madison, Wis. These stands, of which there are four on each table, support the reagent shelf. Besides the gas and water pipes there are six filter pumps, 12

ment. The finish thus secured is an ebony black color which is permanent and very highly resistant to the action of chemicals, such as acids and alkalies, even concentrated sulfuric acid having little or no effect if quickly washed off. (See *Frost*, Journal of Applied Microscopy, I, page 145.) Oak and yellow pine do not take to the stain evenly, but with other kinds of wood likely to be used as table and desk tops the stain comes out in a uniform rich black color which will look like new whenever wiped with a damp cloth or with a little oil.

gas cocks and 3 valves for water connection on each table. The center shelf is 12″ above the top of the table and is 9″ wide. In the middle, pieces of heavy plate glass, 4″ high, are placed so as to separate the reagent bottles on the two sides of the tables. By the use of a single low shelf provided with a plate-glass partition, the view over the entire laboratory is left unobstructed as will appear from the reproductions of the photographs, Figs. 72 and 77. Two gas pipes fitted with Welsbach gas burners and shades extend 18″ above the center shelf.

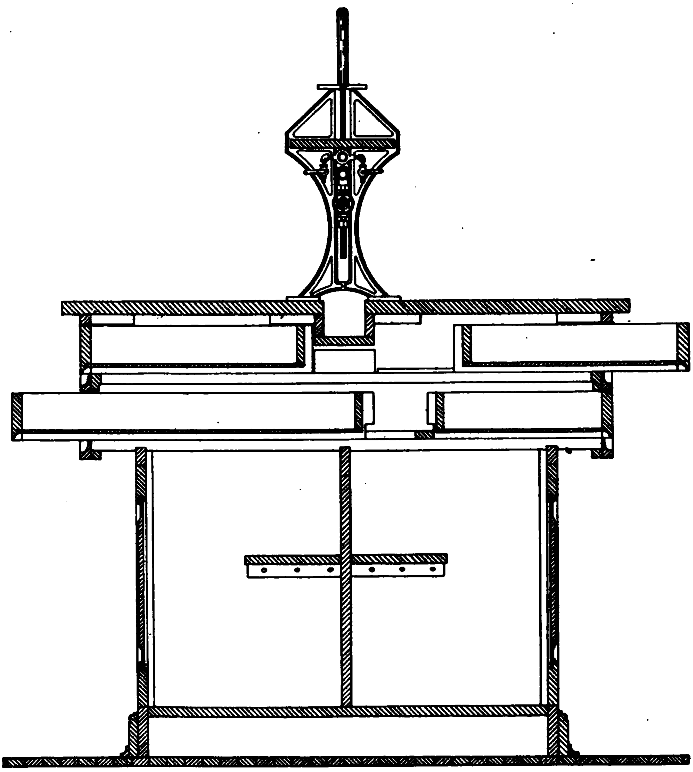

FIG. 74.—Section of our standard laboratory table.

The drawers and cupboards are provided with separate locks, one key unlocking all drawers and cupboards assigned to a student, and a master key is provided for the instructor which fits all locks in the laboratory.

The equipment of the student laboratory consists of two hoods, three shelves for solid reagents along the south wall, alberene top balance table with three analytical balances, oxidation and distillation batteries used in the Kjeldahl method of nitrogen determinations, fat extraction apparatus, Schmidt & Haensch polariscope, etc. An ebony-stained reading table, 12½′ by 28″, is placed on the north wall and on it some of the more important reference books on analytical and agricultural chemistry.

Laboratory hoods. The hoods in our laboratory have alberene tops and plate glass windows. They are 22″ deep and of such a width as required in each case to fit in between the flues and ventilators, etc. The back of the hoods are of ribbed glass, such as is used in this building between offices or laboratories and corridors. The hoods are directly connected with a flue as shown in Fig. 75, all interior wood work being covered by sheet lead in the main part of the hood, and protected by asphalt paint in the top of the hood. Several of the hood glass windows and also the ribbed glass near the wall have cracked from the heat conducted from the burners in the hood during the past year, suggesting that the hoods had better be made 4 to 6″ deeper; it would also doubtless be an improvement if white tiling could be laid in the wall forming the back of the hood as originally provided, rather than ribbed glass. The hoods are fitted with cupboards underneath, used for storing glassware of the kinds most needed in each particular room.

Adjoining the student laboratory on the east is the *Office of the instructor,* a 13½ x 12½′ room, which leads into the supply room for the student laboratory, 13½ x 9 and 14½; the latter has a delivery window with shelf from the student laboratory, and a window facing the corridor through which glassware and chemicals can be taken from the general store room on the opposite side. The fixtures in the office of the instructor include a roll-top desk, reading table, revolving book case, wall book cases and fire-proof vault, analytical balance, chairs, key board, etc., and in the adjoining

store-room, shelving for chemical apparatus, glassware, chemicals, etc.

The *Research laboratory* (Rl. 3) intended for advanced work in agricultural chemistry, has not yet been fitted up.

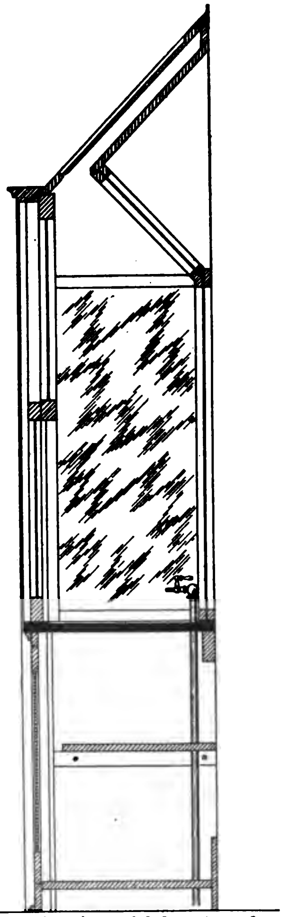

FIG. 75.—Section of laboratory hoods.

The *Dairy laboratory* is a small room, 11½ x 10½, at the west end of the basement corridor. On the west table is a twenty-four bottle Wizard Babcock steam turbine tester; the north half of this table is covered with sheet lead on which the sulfuric acid used in the Babcock test is kept. Along the south wall is a sink and alberene drain table with splash

board, and along the opposite wall, an ebony-stained table with cupboards and a single tier of drawers below, for Babcock test accessories, and an 8′ long shelf, 7″ wide, 15″ above the top of the table, likewise black-stained, for reagents, test bottles, etc. A twelve-bottle Agos Babcock hand tester completes the equipment of this room.

FIG. 76.—View of work room, Perner beet sampler in the foreground to the left; Enterprise and Maercker mills to the right.

On this floor is also located the *Work room* (see Fig. 76) in which a 1 H. P. electric dynamo for running grinding mills, beet sampler, etc., is placed. The tables along the east and west walls are occupied by two Enterprise pulverizing mills (No. 7 run by hand, No. 9 by power), a Maercker mill, a Perner beet sampler, an Enterprise meat chopper, plant press, vise and grind stone, while tools of various kinds are kept in the drawers on the east table.

The *General store room* on this floor is a 21½ x 23′ room, provided with shelving on the east and west walls and two center shelves, 6½′ high, 12′ long and 32″ wide. This has six shelves for glassware, chemicals and chemical apparatus. A freight elevator runs from this room to the upper floors.

The *Sub-basement laboratory* (12 x 12′) is equipped for research work in which a uniform room temperature is of importance. Two delicate analytical balances are kept here, which have been used by Dr. Babcock during the past year in experiments on the loss of weight during chemical reactions.

On the second floor are located the main *Station Laboratories* (see Figs. 77 and 78). The dimensions of the first one of these (R. 40) are 42 x 25 and 28′. It has two standard laboratory tables, modified only as far as the drawers are concerned, which are of the same width and length in both tiers, except in the case of table 4 (Fig. 78), where the drawers in the lower tier alternate in such a way that long drawers for burettes, pipettes, glass tubes and glass rods are on the east side, and short drawers for corks on the west side of the table. The center table, 10 x 4,′ which has an alberene top and an alberene sink, 28 x 18 x 8″ high, has a single tier of five drawers on each side and no cupboards. This table is used for determinations of crude fiber in feeding stuffs, for distillations, glass blowing, etc. It has a shelf over the south half of the table only, directly under which gas and water pipes run, the latter fitted with six Chapman filter pumps.

An extraction battery for 12 flasks is placed on the northeast wall table. This is heated by water bath, the temperature of which is maintained at about 50 deg., either by gas or by electricity. On the same table, which has an alberene top, a Fletcher muffle oven (Monitor furnace), and a Soxhlet drying oven are placed. Two Verbeck & Peckholdt analytical balances with a two-chamber Dupre glass desiccator occupy the table on the south half of the east wall. Like the tables along the north and northwest wall of this room, this has also an alberene top. The washing sink (36 x 20 x 8) with drain table and pine draining-rack occupy the middle of the north wall, and here a water tank connected with the steam pipe system is placed, also the faucet supplying distilled water. On the middle of the north wall is a three-chamber steam drying-oven supported on brackets. This is connected with the high-pressure steam pipe, and from it a ½″ galvanized iron pipe conducts the steam to a large dry-

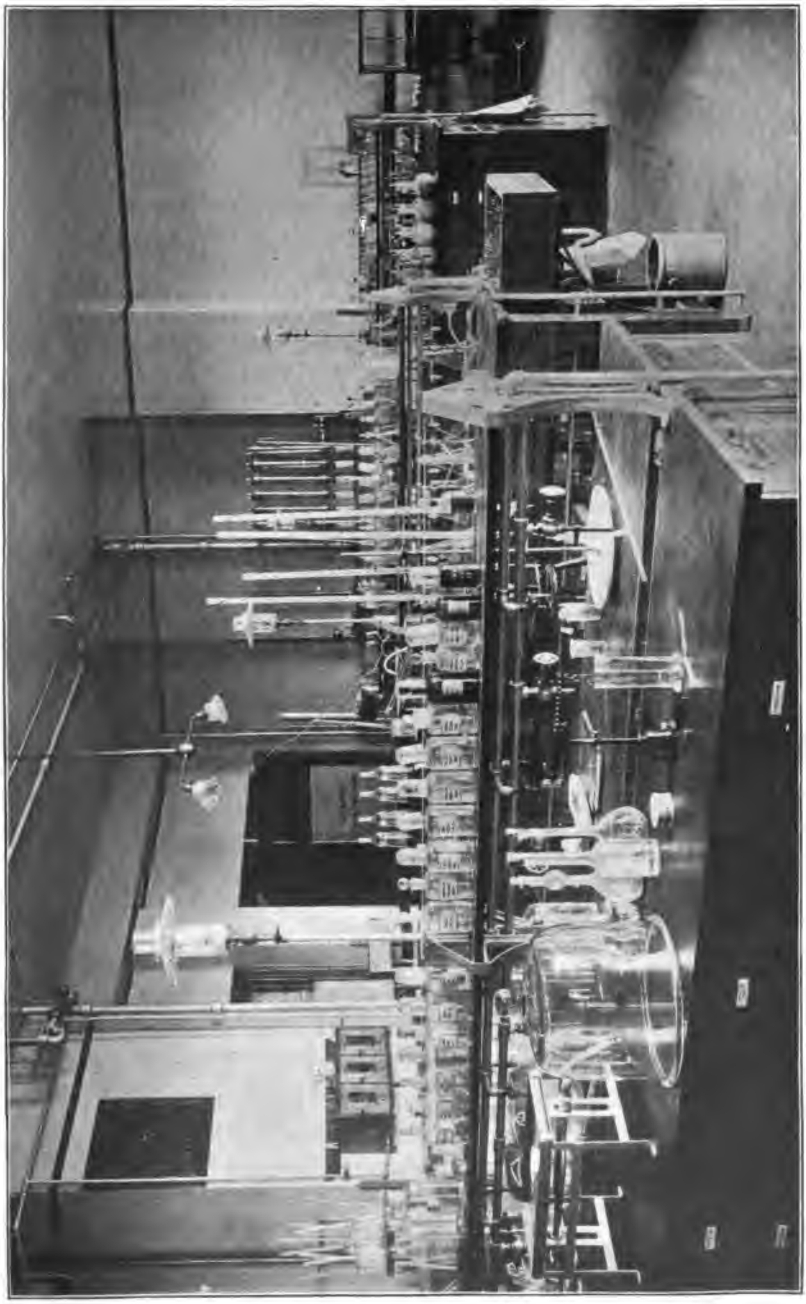

FIG. 77.—View of main station laboratory.

ing oven, 18 x 20 x 22," for drying samples of coarse feed. A steam water-bath, 24 x 15", with six holes, is placed next to this oven, near the east door of the room.

Other fixtures of this room are a reagent case with sliding glass doors on the south wall, 5½′ wide and 6½′ high, for solid reagents, with three cupboards below for larger reagent bottles, acids, etc.; a drying cabinet, 4′ wide, 3′ high and 12" deep, directly over a 19-section radiator on the middle of the south wall. This cabinet has two 11" shelves, 10" apart,

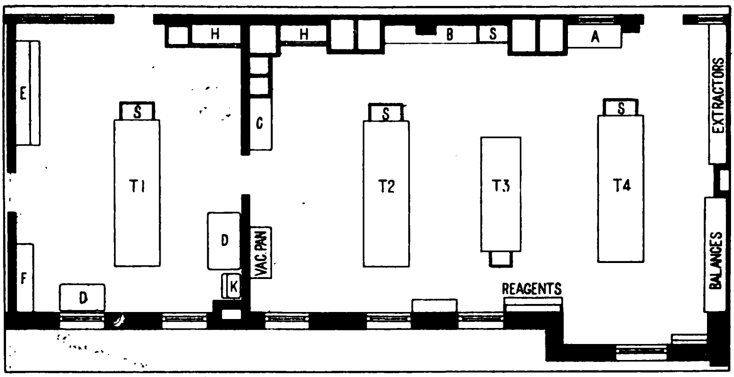

FIG. 78.—Plan of station laboratories on second floor. T1–T4 labortory tables S sinks, A, B, C, & F work tables, D desk, K filing cabinet, H hoods, E glass-case for chemical apparatus.

provided with numerous 1¼" holes and larger, and has ten 1" holes near the top through which the steam from the drying glassware, placed in the cabinet, may escape. A steam vacuum-pan is placed on a movable table on the south half of the east wall, and a 12-bottle Agos Babcock hand tester on the opposite table. The southeast corner of the room is occupied by shelving for samples of substances to be analyzed, with room underneath for larger acid bottles, etc. A small, light, movable table stands at the south of the balance table which holds bottles containing samples to be weighed out for analysis and flasks, drying tubes, etc., used in the analytical work.

Station laboratory No. 2. (Room 38), 25 x 20¼", adjoins our main Station laboratory on the west. This is intended for miscellaneous chemical work, sugar analysis, specific gravity

determinations, microscopic work, etc. A flat-top desk is used for microscopic work. A large glass-case occupies the north half of the west wall, and on the south half of the east wall a Macey combined filing cabinet and book case is placed, and next to it a reading table. The book case contains copies of our more important works on agricultural and technical analysis. In this case station record cards and writing supplies are also kept.

Other equipment in this room is a Schmidt & Haensch triple-field half-shadow polariscope with complete accessories, a Bausch & Lomb CA microscope with accessories, a Westphal balance, a set of delicate hydrometers (.7 to 1.86), revolving tin aspirator, a Lunge & Orsat apparatus for analysis of combustion gases, Wollny–Zeiss butter refractometer, and many other pieces of scientific apparatus.

The private laboratory of the chief chemist is located in the southwest corner of second floor. It is a 25 by 20 foot room fitted up with one standard laboratory table with complete fixtures, one Sartorius and one Verbeck & Peckboldt balance, one mercury vacuum pump, one Duplex "Geryk" vacuum pump, one flat-top desk, chairs, etc.

Two laboratories are located on third floor of the building, viz., the *Nitrogen laboratory* (R. 58) and a *Research laboratory* (R. 54) (see Figs. 79 and 80). The nitrogen laboratory is arranged for the sole work of determination of nitrogen in agricultural products, primarily by the Kjeldahl method. It is a room, 28 x 14½′, provided with a 10 x 4 alberene table on which the distillation battery for 12 determinations and a titration stand are placed; the top of the table is cut out in the center so as to leave an outside 3″ strip raised ¼ to ½″, and drains toward the sink (30 x 20 x 8″ high) on the north end. Underneath are drawers and cupboards as on our standard laboratory tables. On the east wall is an alberene-top balance table with a Verbeck & Peckholdt analytical balance. On the opposite side of the ventilator a 12′ long hood for oxidation of samples. A flat-top desk on the west wall completes the fixtures of this room.

Oxidation battery (see Fig. 80). This was made according to the pattern of a battery in use at the Connecticut (New Haven) Experiment Station. The iron stand which holds

12 flasks was cast in the foundry of S. H. Barnum, New Haven, Connecticut. Above the stand a horizontal lead pipe, 4″ in diameter, is connected directly with the flue by a vertical lead pipe, 6″ in diameter at the base and 5″ at the top. The horizontal lead pipe has 12 holes, 1 5–8″ in diameter, placed in line with the holes of the stand, the position of the pipe being adjusted so that 800 c. c. short-necked Jena flasks, which are used in our work for both oxidation and distillation, will rest at an angle of about 60 degrees when placed on the stand with the neck projecting slightly into the corresponding hole in the pipe.

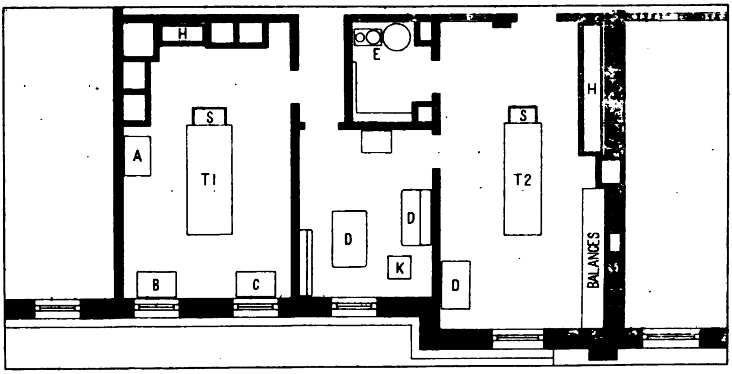

FIG. 79.—Plan of laboratories and office on third floor. Room to the right, nitrogen laboratory; in the center, office of assistant chemist, and to the left, research laboratory. T1–T2 laboratory tables, A, B, C work tables, H hood, D desk, E distilled-water apparatus.

This arrangement has given excellent satisfaction during the past year. There is always sufficient draught created to carry away all sulfurous acid fumes, even if only one or two flasks are being heated, and with the window of the hood left open. The unpleasant feature of the Kjeldahl method of nitrogen determination has, therefore, been entirely done away with by this device. The total cost of the stand and the lead flue made by a local tinsmith was $23.00.

Instead of common Bunsen burners, the stand is provided with such burners placed in horizontal positions, to which snugly-fitting ½″ brass Tees are attached. The latter are 2½″ x 4″ long and are closed with a common cork at the lower end as shown in Fig. 81. The advantages of this ar-

rangement are twofold; *first,* if the flask that is being heated should break, the contents will drop into the vertical tube of the Tee which can be readily cleaned, and the burner will not be clogged or spoiled by the corroding acid solution; and *second,* the flame can be better regulated than with the ordinary vertical Bunsen burner; an additional advantage, which is of importance especially in case of the distillation

FIG. 80.—Partial view of corner in nitrogen laboratory, oxidation battery in the hood, in the background; distillation battery in the foreground, to the right.

apparatus where this arrangement has also been adopted, is found in the fact that the Tee can be readily turned to either side so as to reinforce the heating of neighboring flasks, if deemed necessary. This modification of Bunsen burners is capable of extended use, e. g., under hot-water oven or tanks and other places where two smaller flames, separated by a piece of brass tubing of any desired length, may be preferred to one large one. It is found here as in case of the oxidation battery, that such burners can be regulated much better than ordinary Bunsen burners.

The *distillation battery* has a similar cast-iron stand to that used in the oxidation battery, and is connected with similar modified Bunsen burners. The condensers are of original

construction and call for special description (see Fig. 81). The battery consists of twelve 20″ condensers, 4 5–8″ apart from center to center. The coolers of the condensers are 1″ galvanized iron pipes, 14″ long. 1″ galvanized iron crosses are screwed on each end of the condensers and onto these again, brass stuffing boxes, fitting the crosses; ½″ glass condensing tubes are run through the stuffing boxes; the tubes are bent at the lower end, as shown in the figure, so that the glass tube connected with it by means of a piece of rubber tubing, which dips into the receiver, will hang in a nearly vertical

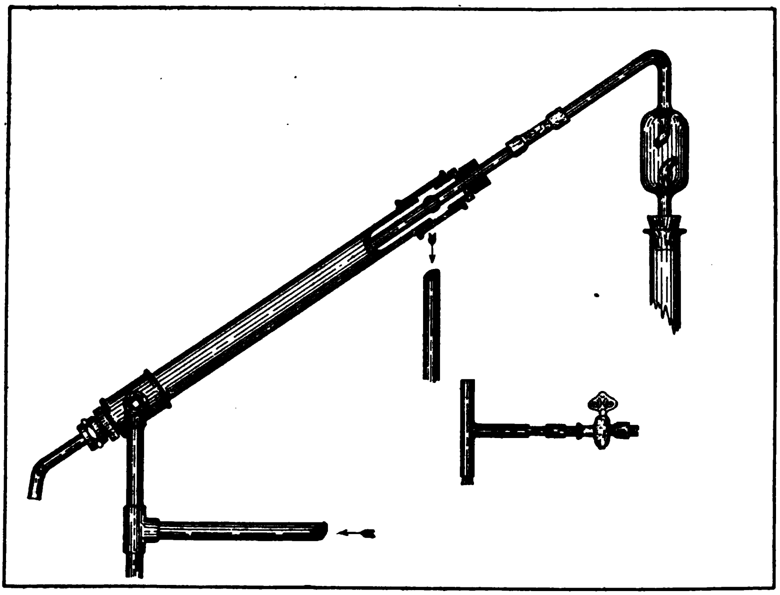

FIG. 81.—Section of Kjeldahl distillation apparatus. Below, to the right, Bunson burned with ⅛″ brass Tee attached.

position. The condensers are connected with each other by quarter-inch pipes at the crosses, and 3–8″ pipes supplying and emptying the water cooling the condensers are connected so as to serve as support for the battery at the same time. While it is next to certain that a condenser is an unnecessary feature of the distillation in the Kjeldahl method, provisions for cooling were made in constructing this battery, perhaps from conservatism and because cooling is still the universal practice in American experiment station laboratories, so far

as the information of the writer goes. Fig. 80 gives a partial view of our Kjeldahl distillation battery, with the oxidation battery in the hood in the background.

The small room (R. 58A) adjoining the nitrogen laboratory is occupied by our distilled-water apparatus and by shelving for feed samples, sulfuric acid, etc. The *distilled-water apparatus*

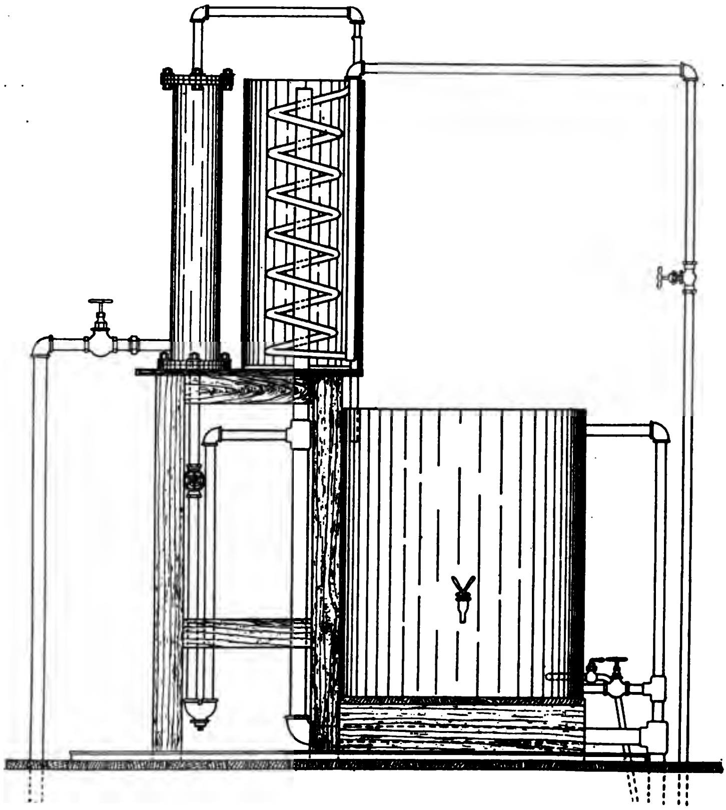

FIG. 82.—Distilled-water apparatus.

(see Fig. 82) is connected with the steam pipe by a 1½″ iron pipe; this is attached to an iron cylinder, 6″ wide and 3′ high, which is filled with pieces of brick and pebbles intended to retain rust and other mechanical impurities of the condensed water. The steam passes in a worm of a ½″ tin pipe through a cooler, 15″ in diameter and 3′ high, and when condensed runs into the distilled water tank, which is 3′ high and 30″

in diameter. From this the distilled water is conducted in tin pipes to the various chemical and bacteriological laboratories. The iron cylinder in front of the condenser is provided with a 3′ long iron trap by which the dirty water condensing in the steam pipe can be emptied so that it will not be carried into the condenser. This trap is connected with an overflow pipe from the condenser which runs into the waste pipe, and an overflow pipe from the distilled water tank is also connected with this pipe. The distilled water tank, which is made of heavy copper, tinned inside, is provided with a copper lid and with a pipe at the bottom for the draining of wash water if it should need cleaning. The faucet shown in Fig. 82, about one-third from the bottom of the tank, was put on for the purpose of drawing distilled water in the adjoining nitrogen and research laboratories. The whole distilled water apparatus was made from plans prepared by Dr. Babcock, chief chemist, by a local tinsmith and cost $50.00 complete with connections. It has proved of ample capacity for the needs of both our station and student chemical and bacteriological laboratories.

The *Research laboratory* (R. 54) has been used during the past year as the temporary quarters of the chemical department of the State Dairy and Food Commission, since the destruction of the laboratory of the Commission by the Capitol fire last January. This room is 25 x 15,′ is fitted up with a standard laboratory table, 10 x 4′, and with hood, tables, desk, stools, etc. Most of the chemical apparatus at the present time in this laboratory is the property of the State Dairy and Food Commission.

Offices. Besides the office of the instructor in agricultural chemistry in the basement already referred to, the following offices are occupied by the chemical staff of the Experiment Station.

On the first floor, the *office of the chemist* (R. 26), a room 28 x 13½′, of which a portion, 9 x 10′ is occupied by the closet (R. 26A) used for hanging wardrobe, wash room, duplicate report room, etc. The office itself is fitted with library shelving on the east and west walls, with a roll-top

desk, revolving book case, a Macey combination cabinet for blanks of various kinds, letter file, book case, etc., a reading table, office telephone, office chairs, etc. On the east side it opens into a fire-proof vault with double doors and combination lock, which is used for storage of laboratory records and other valuable property of the chemical department.

On the second floor, at the west end of the corridor, is the *office of the chief chemist* (R. 36), dimensions 17 x 12.′ This has the following fixtures: one roll-top desk, revolving book case, library shelving on the south and east walls, telephone connection, reading table, chairs, etc.

The *office of the assistant chemist,* Mr. Olson, is on the third floor of the building (see Fig. 79). This has similar fixtures as the other offices in the building: roll-top desk, reading table, revolving book case, library shelving, chairs, etc.

The valuation of the personal property of the chemical department, including laboratory and office fixtures, apparatus, supplies, etc. (exclusive of gas and electric fixtures), aggregated $11,516.58, according to the last itemized inventory taken during May, 1904. As will be seen from the description of our equipment given in the preceding pages, our facilities for the work we are called upon to do are up to the standard of modern requirements, and are of a character to inspire to the best efforts in the discharge of our duties.

B. Laboratories in Agricultural Bacteriology.

H. L. RUSSELL.

In Fig. 83 is shown the floor plan of the Station laboratory, situated on the second floor, together with portions of the adjacent rooms used in connection with the bacteriological work. The laboratory is 18 x 54 feet. The private office (Room "B," Fig. 83) of the head of the department, is connected by a door with room "A" used as a private laboratory. Rooms "C, D, and F" are used as store rooms for the reception of glassware and general laboratory supplies. They give much more room than the wall cases usually provided for this purpose, and at a much less cost. The main store room "F" con-

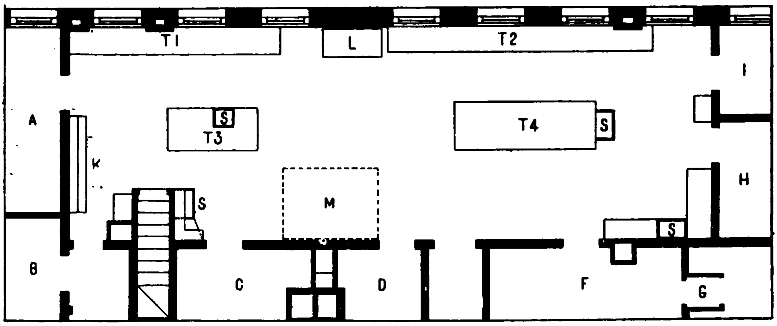

FIG. 83—Floor plan of the Station Bacteriologcal Laboratory.

nects with a small elevator, so that supplies can easily be moved from the basement to the upper floors. The smallest room, "D," is used as a pure culture room, and for museum material in course of preparation. Room "H" is provided with a work bench and is used as a storage room for rough material. The stairway leads to the student laboratory immediately below, and from there to the animal rooms in the basement.

Microscopic work is provided for on the wall tables "T1 and T2," which are bracketed from the solid wall. The tops

of the tables, 30″ above the floor, are ⅞″ maple, finished in aniline black. This wood takes this finish very well, even better than oak. It is well, however, to oil the under surface of the table top before placing in position, as the subsequent treatment has a tendency to cause warping. Fig. 84 gives a view of the west end of the laboratory, showing in more detail one of the wall tables. The drawers are rather shallow for microscopic accessories and papers. Each window space arranged for microscopic work is provided with a sliding elbow rest for writing bed. Distilled water and gas are piped open, beneath the wall shelf, offsets for gas being taken off at both the right and left of each window used for microscopical work, at the left connection for Bunsen burner and Welsbach, at the right connection for Bunsen burner alone.

The following arrangement provides distilled water over all the working tables. The water is condensed on the floor above. A description of the condensing apparatus is given on p. 364. From the storage tank it is piped in block-tin tubing to the various laboratories. In the corner of the main laboratory, about two feet above the table tops, is placed a small reservoir. From this tank an outlet pipe runs along the wall under the wall tables; offsets from this are taken off at the right of each window, and are connected with nickle-plated pantry cocks. This arrangement gives an ample supply of distilled water at a comparatively low pressure, that is well suited for irrigation of cover glasses and microscopic preparations. The wall tables are not provided with drainage, small dishes being used below the water taps.

The center table "T4" is of the same type as is used in the chemical laboratories, p. 354, except that the shelf and plumbing is carried but half the length of the table. T3, a general work table for making of cultures, etc., is provided with a small leaded sink. Below are drawers for the storage of glassware used in making cultures, a cupboard for small supplies of media. The opposite side contains drawers and cupboards. The case for storage of chemicals, "K" Fig. 83, is shown also in Fig. 84 by the door leading to the private laboratory.

FIG. 84—West end of the Station Bacteriological Laboratory showing the construction of wall tables.

A large McCray refrigerator, L Fig. 83, is used for all purposes requiring refrigeration. The ice chamber holds about 400 lbs., and the drip is so arranged that the waste water can be used to cool a small gelatine incubator. The refrigerator also serves for the storage of pure cultures after they have developed; cold storaging these cultures prevents desiccation, and retards metabolic activity, thus prolonging very materially the life of each generation. In this way, the routine work of transferring cultures is greatly reduced. The stock media in bulk is also stored in the refrigerator.

The high temperature incubators which are to be installed in the space marked "M" Fig. 83, are to be small, well insulated rooms, heated by gas flames placed outside the rooms proper, the heat is to be conducted around the walls of the rooms in pipes which will discharge into a flue. This arrangement has been used with success in a number of European laboratories, namely, von Freudenreich & Tavel at Berne.[1]

The leakage of gas, in case a flame went out, would pass into the ventilator, and would lessen materially the danger from fire.

The student laboratory has a floor space of 1,000 sq. ft., and is being fitted up to accommodate 14 students.

Bacteriological kitchen. Immediately adjacent to this laboratory is the kitchen or media room in which all media are prepared and glassware cleaned. Fig. 85 shows a portion of this room. The tap for distilled water is shown at the right. A gas range is used for cooking, the oven being used as a dry air sterilizer. A horizontal Bramhall Deane autoclave is heated by means of a steam coil carrying high pressure steam which is available during the entire year. Circulation is secured by discharging the outlet pipe from the coil into the soil pipe at the left of the room. The alberine wall table is used for filtration and tubing of media. A large alberine sink carried on brackets is provided with two water taps, so that one can be used for filtering media under diminished pressure. The can at the left is connected with

[1] Cent. f. Bakt., Abt. I, Bd. 24, pp. 670, 742.

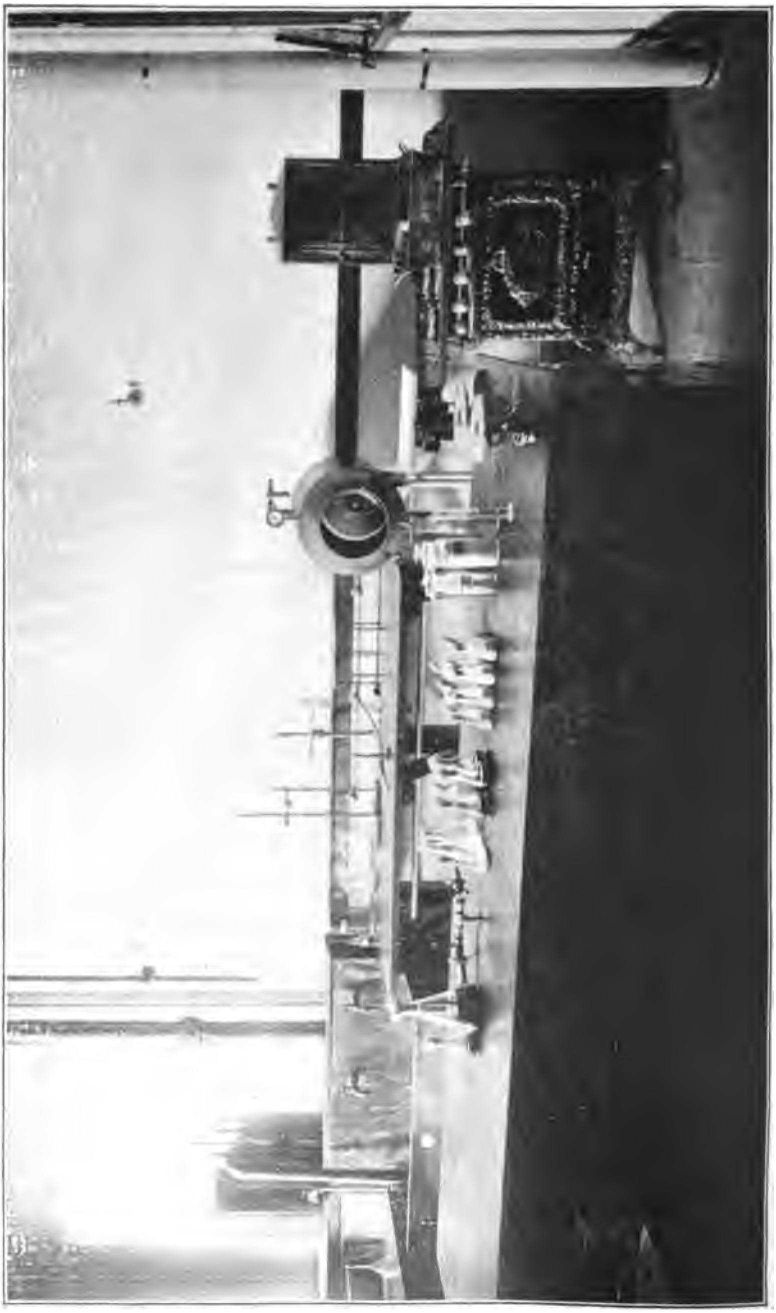

FIG. 55.—Bacteriological kitchen where various kinds of culture media are prepared and glassware cleaned.

the water and high pressure steam, so that a supply of hot water for washing glassware is available at all times.

The center table contains drawers for material used in media making. A case, not shown in the picture, provides storage room for clean glassware. The drawers below are interchangeable with those in table T3 in the Station laboratory, so that they may be transferred entire without handling contents. This room connects with the elevator.

Animal Quarters. The animal apartments consist of three rooms in the basement and a hospital room on each laboratory floor. The stock animals are kept in the basement rooms while a separate feed room holds the supply of grains and fodder. The hospital rooms are provided with cages for keeping the infected animals separate. Provision is made in the basement for the later installation of a crematory for the burning of garbage and dead animals.

In the lecture rooms used by the bacteriological department are installed projection lanterns. In the right hand corner in Fig. 76 is shown the compound motor-generator which is used in connection with the projection apparatus for the conversion of the alternating into the direct electric current.

THE WISCONSIN FEEDING STUFF LAW.

(CHAPTER 377, LAWS OF 1901.)

Section 1. The term "concentrated commercial feeding stuffs," as used in this act, shall include linseed meals, cotton seed meals, pea-meals, cocoanut meals, gluten meals, oil meals of all kinds, gluten feeds, maize feeds, starch feeds, sugar feeds, sucrene, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat feeds, ground beef or fish scraps, mixed feeds of all kinds, also all condimental stock foods, patented and proprietary stock foods claimed to possess nutritive as well as medicinal properties, and all other materials intended for feeding to domestic animals; but shall not include hays and straws, the whole seeds nor the unmixed meals made directly from the entire grains of wheat, rye, barley, oats, Indian corn, buckwheat, dried brewers' grains, wet brewers' grains, malt sprouts, sorghum, and broom corn. Neither shall it include wheat, rye and buckwheat brans or middlings not mixed with other substances, but sold separately, as distinct articles of commerce, nor pure grains ground together.

Section 2. Every manufacturer, company or person who shall sell offer or expose for sale or for distribution in this state any concentrated commercial feeding stuff, used for feeding farm live stock, shall furnish with each car or other amount shipped in bulk and shall affix to every package of such feeding stuff in a conspicuous place on the outside thereof a plainly printed statement clearly and truly certifying the number of net pounds in the car or package sold or offered for sale, the name or trade mark under which the article is sold, the name of the manufacturer or shipper, the place of manufacture, the place of business and the percentages it contains of crude protein, allowing one per centum of nitrogen to equal six and one-fourth per-centum of protein and of crude fat, both constituents to be determined by the methods prescribed by the Director of the Wisconsin Agricultural Experiment Station. Whenever any feeding stuff is sold at retail in bulk or in packages belonging to the purchaser, the agent or dealer, upon request of the purchaser shall furnish to him a certified copy of the statement named in this section.

Section 3. Before any manufacturer, company or person shall sell, offer or expose for sale in this state any concentrated commercial feeding stuffs, he or they shall for each and every feeding stuff bearing a distinguishing name or trade mark, file annually during the month of December with the Director of the Wisconsin Agricultural Experiment Station a certified copy of the statement specified in the preceding section, said certified copy to be accompanied, when the Director shall so request, by a sealed glass jar or bottle containing at least one pound of the feeding stuff to be sold or offered for sale, and the company or person furnishing the said sample shall also submit a satisfactory affidavit that said sample corresponds within reasonable limits to the feeding stuff which it represents in the percentage of protein and fat which it contains.

Section 4. Each manufacturer, importer, agent or seller of any concentrated commercial feeding stuffs shall pay annually to the Director

of the Wisconsin Agricultural Experiment Station a license fee of twenty-five dollars. Whenever a manufacturer, importer, agent or seller of concentrated commercial feeding stuffs desires at any time to sell such material and has not paid the license fee therefor in the preceding month of December, as required by this section, he shall pay the license fee prescribed herein before making any such sale. The license fees received by such Director pursuant to the provisions of this section shall be paid into the treasury of the university and shall constitute a special fund from which to defray the expenses incurred in making the inspections and analyses required by this act and enforcing the provisions thereof, and he shall report annually to the regents of the University of Wisconsin the amount received and the expense incurred for salaries, laboratory expenses, chemical supplies, traveling expenses, printing and other necessary matters. Whenever the manufacturer, importer or shipper of concentrated commercial feeding stuffs shall have filed the statement required by section two of this act and paid the license fees as prescribed in this section, no agent or seller of such manufacturer, importer or shipper shall be required to file such statement or pay such fee.

Section 5. The Director of the Wisconsin Agricultural Experiment Station shall annually analyze or cause to be analyzed at least one sample to be taken in the manner hereinafter prescribed, of every concentrated commercial feeding stuff sold or offered for sale under the provisions of this act. Said Director shall cause a sample to be taken, not exceeding two pounds in weight, for said analysis, from any lot or package of such commercial feeding stuff which may be in the possession of any manufacturer, importer, agent or dealer in this state, but said sample shall be drawn in the presence of the parties in interest or their representatives, and taken from a parcel or a number of packages which shall not be less than ten percentum of the whole lot sampled, and shall be thoroughly mixed, and then divided into equal samples, and placed in glass vessels, and carefully sealed and a label placed on each, stating the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the person taking the sample, and by the party or parties in interest or their representative at the drawing and sealing of said samples; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled; and the sample or samples retained by the director shall be for comparison with the certified statement named in section three of this act. The result of the analyses of the sample or samples so procured, together with such additional information as circumstances advise, shall be published in reports or bulletins from time to time.

Section 6. Any manufacturer, importer or person who shall sell, offer or expose for sale or distribution in this state any concentrated commercial feeding stuff, without complying with the requirements of this act, or any feeding stuff which contains substantially a smaller percentage of constituents than are certified to be contained, shall, on conviction in a court of competent jurisdiction, be fined not less than twenty-five nor more than one hundred dollars for the first offense, and not more than two hundred dollars for each subsequent offense.

Section 7. Any person who shall adulterate any kind of meal or ground grain or other feeding stuff with milling or manufacturing offals, or any other substance whatever, for the purpose of sale, unless the true composition, mixture or adulteration thereof is plainly marked or indicated upon the package containing the same or in which it is offered for sale; or any person who sells, or offers for sale any meal, ground grain or other feeding stuff which has been so adulterated, unless the true composition, mixture or adulteration is plainly marked

or indicated upon the package containing the same, or in which it is offered for sale, shall be fined not less than twenty-five or more than one hundred dollars for each offense.

Section 8. Whenever the director aforesaid becomes cognizant of the violation of any of the provisions of this act, he shall report such violations to the dairy and food commissioner, and said commissioner shall prosecute the party or parties thus reported; but it shall be the duty of said commissioner upon thus ascertaining any violation of sections two, three or four of this act, to forthwith notify the manufacturer, importer or dealer in writing and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of any concentrated commercial feeding stuff if the same shall be found substantially equivalent to the certified statement named in section two of this act.

Section 9. This act shall take effect July 1st, nineteen hundred and one.

THE WISCONSIN FERTILIZER LAW.

[Sections 1494*c*, 1494*d* and 1494*e*, Wisconsin Statutes of 1898.]

SECTION 1494*c*. Every person who shall, in this state, sell or expose for sale any commercial fertilizer or any material used for fertilizing purposes, the price of which exceeds ten dollars per ton, shall affix to every package of such fertilizer or material, in a conspicuous place on the outside thereof, a plainly printed statement clearly and truly certifying the number of net pounds therein, name or trade-mark under which the article is sold, name of the manufacturer or shipper, place of manufacture, place of business of the manufacturer and of the following fertilizing constituents, namely: The percentage of nitrogen in an available form, of potash soluble in water and of available phosphoric acid, soluble and reverted; as well as total phosphoric acid. Every such person shall also file with the director of the agricultural experiment station of the university of Wisconsin, in the month of December in each year, a certified copy of such statement for every such fertilizer or material bearing a distinguishing brand or trade-mark and which he sells or exposes for sale, which copy shall, when required by such director, be accompanied by a sealed glass jar or bottle containing at least one pound of such fertilizer or material, and an affidavit that such sample corresponds, within reasonable limits, to the fertilizer or material which it represents in the percentage of the aforesaid constituents, which affidavit shall apply to the remaining portion of the then calendar year. Additional brands of such fertilizer or material may be offered for sale during the year, provided samples and affidavits are so filed at least one month before they are offered, in which case an analysis fee of double the usual amount must be paid. A deposit of the sample of fertilizer shall be required by said director unless the person selling or offering for sale a fertilizer or material within this section shall certify that its composition for the succeeding year is to be the same as given in the last previously certified statement, in which case the furnishing of a sample shall be at the discretion of said director.

SECTION 1494*d*. Said director shall analyze or cause to be analyzed all such samples and publish the results of such analysis in a bulletin or report on or before the first day of the next succeeding April. Every manufacturer, importer, agent or seller of any such fertilizer or material shall pay annually to said director for each brand thereof sold within this state the sum of twenty-five dollars, and upon doing so and complying with the other provisions of law shall receive from him a certificate of such compliance which shall be a license for the sale of each brand thereof within the state for the calendar year for which such fee is paid. All moneys received by said director pursuant to this section shall be paid into the treasury of said station. Any person who shall sell or expose for sale any commercial fertilizer or material used for fertilizing purposes which is within the provisions of the preceding section without complying with the foregoing provisions or which contains a substantially smaller percentage of fertilizing constituents than are indicated by the printed statement thereon shall be

punished by a fine of one hundred dollars for the first offense and of two hundred dollars for each subsequent offense.

SECTION 1494*e*. Said director shall annually analyze or cause to be analyzed at least one sample of every fertilizer or material used for fertilizing purposes sold or exposed for sale under the two preceding sections and enforce their provisions by prosecuting or causing the prosecution of every person who shall violate them. He may in person or by deputy, on tendering the value thereof, take a sample, not exceeding two pounds, for said analysis from any lot or package of fertilizer or any material used for fertilizing purposes which may be in the possession of any manufacturer, importer, agent or dealer in this state; said sample shall be drawn in the presence of the person from whom taken or his representatives, be taken from a parcel or a number of packages which shall not be less than ten per centum of the whole lot sampled, be thoroughly mixed and divided into two equal samples, placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn, the time and place of such taking; said label shall be signed by the director or his deputy and such person or his representative at the drawing and sealing of said samples; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled; the sample retained by the director shall be for comparison with the certified statement named in section 1494c. The result of the analysis of the sample or samples so procured shall be reported to the person requesting the analysis and be published in a report or bulletin to be issued within a reasonable time.

EXCHANGES.

This Station takes pride in the fact that it has on file an almost complete list of the leading agricultural papers in the United States, besides many from foreign countries, and some not strictly treating of agriculture. These papers come to the Station in exchange for its reports and bulletins. While of the highest value to those connected with the Station as the expression of agricultural experience and sentiment, they are placed where they can be read and referred to by our agricultural students, and others of the University, as well as by visitors. Any one desiring sample copies of these papers can, as a rule, secure them upon application to the publishers, at the addresses given.

FOREIGN EXCHANGES.

Agricultural Bulletin, Straits Settlement, Singapore, East Indies.
Agricultural Gazette of New South Wales, Sydney, Australia.
Agricultural Journál, Cape Town, South Africa.
Agricultural Journal and Mining Record, Maritzburg, Natal.
Agricultural News, Bridgetown, Barbados, W. I.
Australian Farm and Home, Melbourne, Australia.
Australian Garden & Field, Adelaide, Australia.
Boletim da Agricultura, São Paulo, Brazil.
Boletin de Agricultura y Ganaderia, Buenos Aires, Argentina.
Boletin de la Secretaria de Fomento, City of Mexico.
Bulletin de l'Agriculture, Brussels, Belgium.
Bulletin of the Dep't of Agriculture, Kingston, Jamaica.
Bulletin des Seances de la Societe Nationale d' Agriculture de France, Paris, France.
Bulletin de la Societé d' Agriculture, Sciences et Arts de la Sarthe, Le Mans, France.
Chronique Agricole du Canton du Vaud, Lausanne, Switzerland.

Creamery Journal, London.

Extrait des Travaux de la Soc. Centr. d'Agr. de la Seine Inf., Rouen, France.

Farmer's Advocate, London, Ontario.

Farming World, Toronto, Canada.

Field, London, England.

Hochschul-Nachrichten, Berlin, Germany.

Irish Farming World, Dublin, Ireland.

Journal für Landwirtschaft, Berlin, Germany.

Journal of Agriculture and Industry of South Australia, Adelaide, Australia

Journal of the Bath and West of England Society, Bath, England.

Journal of the British Dairy Farmers' Ass'n, London, England.

Journal of the College of Science, Imperial University, Tokyo, Japan.

Journal of the Council of Agriculture, Hobart, Tasmania.

Journal of the Department of Agriculture of West Australia, Perth, West Australia.

Journal of the Department of Agriculture of Victoria, Melbourne, Australia.

Journal of the Board of Agriculture, London, England.

Journal of Royal Agricultural Society, London, England.

Journal of the Royal Horticultural Society, London, England.

Kgl. Landtbruks-Akademiens Handlingar och Tidskrift, Stockholm, Sweden.

L'Agricoltura Moderna, Milan, Italy.

Landwirtschaftliche Wochenblatt f. Schlesw.-Holstein, Kiel, Germany.

Live Stock Journal, London, England.

Milch Zeitung, Leipzig, Germany.

Maritime Farmer, Sussex, N. B.

New Zealand Dairyman, Wellington, N. Z.

North British Agriculturist, Edinburgh, Scotland.

Nor'-West Farmer, Winnipeg, Manitoba, Canada.

O Agricultor Pratico, Recife, Brazil.

Queensland Agricultural Journal, Brisbane, Australia.

Rural World, London, England.

Station, Farm and Dairy, Sydney, Australia.

Tidsskrift for det norske Landbrug, Christiania, Norway.

Tidsskrift for Landökonomi, Copenhagen, Denmark.

Transvaal Agricultural Journal, Pretoria, South Africa.

Ugeskrift for Landmänd, Copenhagen, Denmark.

Weekly Times, Melbourne, Australia.

West Indian Bulletin, Bridgetown, Barbados, W. I.

DOMESTIC EXCHANGES.

Acker und Gartenbau Zeitung, Milwaukee, Wis.
Agricultural Epitomist, Spencer, Ind.
Agricultural Experiments, Minneapolis, Minn.
American Agriculturist, Chicago, Ill.
American Cultivator, Boston, Mass.
American Fertilizer, Philadelphia, Penn.
Amercian Grange Bulletin, Cincinnati, O.
American Hay, Flour and Feed Journal, New York, N. Y.
American Sheep Breeder, Chicago, Ill.
American Sugar Industry and Beet Sugar Gazette,, Chicago, Ill.
American Swineherd, Chicago, Ill.
American Thresherman, Madison, Wis.
Arboriculture, Chicago, Ill.
Breeders' Gazette, Chicago, Ill.
Bulletin of the National Ass'n of Wool Manufacturers, Boston, Mass.
California Cultivator, Los Angeles, Cal.
Cheese and Dairy Journal, Whitewater, Wis.
Chicago Daily Drovers' Journal, Chicago, Ill.
Chicago Live Stock World, Chicago, Ill.
Cold Storage, New York, N. Y.
Colman's Rural World, St. Louis, Mo.
Commercial Poultry, Chicago, Ill.
Cranberry Grower, Cranmoor, Wis.
Creamery Journal, Waterloo, Ia.
Dairy World, Chicago, Ill.
Dog Fancier, Battle Creek, Mich.
Elgin Dairy Report, Elgin, Ill.
Farm and Firesde, Chicago, Ill.
Farm, Field and Fireside, Chicago, Ill.
Farm, Garden and Poultry, Hammonton, N. J.
Farm Home, Springfield, Ill.
Farm Journal, Philadelphia, Pa.
Farm Life, Chicago, Ill.
Farm News, Springfield, Ohio.
Farm, Stock and Home, Minneapolis, Minn.
Farm Students' Review, St. Anthony Park, Minn.
The Farmer, St. Paul, Minn.
Farmers' Guide, Huntington, Ind.
Farmers' Record, Milwaukee, Wis.
Farmers' Review, Chicago, Ill.
Farmers' Sentinel, Milwaukee, Wis.
Farmers' Tribune, Des Moines, Ia.
Farmers' Voice, Chicago, Ill.
Field and Farm, Denver, Colo.
Flour and Feed, Milwaukee, Wis.
Geflügel Züchter, Wausau, Wis.
Goodall's Farmer and Weekly Drovers' Journal, Chicago, Ill.
Guernsey Herd Register and Breeders' Journal, Peterboro, N. H.
Hoard's Dairyman, Fort Atkinson, Wis.
Holstein–Friesian Register, Brattleboro, Vt.
Holstein–Friesian World, Ithaca, N. Y.
Horse-Shoers' Journal, Detroit, Mich.
Hospodar, Omaha, Neb.
Hospodarske Listy, Chicago, Ill.
Homestead, Des Moines, Ia.
Indiana Farmer, Indianapolis, Ind.
Irrigation Age, Chicago, Ill.
Jersey Bulletin, Indianapolis, Ind.
Kansas Farmer, Topeka, Kan.

Kimball's Dairy Farmer, Waterloo, Iowa.
Lincoln Freie Presse, Lincoln, Neb.
Live Stock and Dairy Journal, Fresno, Cal.
Live Stock Report, Chicago, Ill.
Louisiana Planter, New Orleans, La.
Metropolitan and Rural Home, New York, N. Y.
Missouri Agricultural College Farmer, Columbia, Mo.
Modern Farmer and Busy Bee, St. Joseph, Mo.
Modern Miller, St. Louis, Mo.
National Farmer, Winona, Minn.
National Farmer and Stock Grower, St. Louis, Mo.
Nebraska Farmer, Omaha, Neb.
New England Homestead, Springfield, Mass.
New York Produce Review and American Creamery, New York, N. Y.
North American Farmer, Columbus, Ohio.
Northwest Horticulturist, Tacoma, Wash.
Northwestern Agriculturist, Minneapolis, Minn.
Nut Grower, Peulan, Ga.
Orange Judd Farmer, Chicago, Ill.
Oregon Agriculturist, Portland, Ore.
Our Horticultural Visitor, Kinmundy, Ill.
Pacific Rural Press, San Francisco, Cal.
Pacific Tree and Vine, San José, Cal.
Practical Farmer, Philadelphia, Pa.
Practical Fruit Grower, Springfield, Mo.
Reliable Poultry Journal, Quincy, Ill.
Southern Farm Magazine, Baltimore, Md.
Southern Fruit Grower, Chattanooga, Tenn.
Southern Planter, Richmond, Va.
Successful Farming, Des Moines, Ia.
Successful Poultry Journal, Chicago, Ill.
Sugar Beet, Philadelphia, Penn.
Texas Farmer, Dallas, Texas.
Tobacco Leaf, New York, N. Y.
The Trade, Baltimore, Md.
Up-to-Date Farming, Indianapolis, Ind.
Wallace's Farmer, Des Moines, Ia.
Weekly Chronicle, San Francisco, Cal.
West Virginia Farm Review, Charleston, W. Va.
Western Fruit Grower, St. Joseph, Mo.
Western Swine Breeder, Lincoln, Neb.
Wisconsin Agriculturist, Racine, Wis.
Wisconsin Homestead, Milwaukee, Wis.
Wool Markets and Sheep, Chicago, Ill.

STATE PAPERS.

Record, Algoma.
Advocate, Amherst.
Weekly News Item, Antigo.
Eagle, Augusta.
Record, Bloomington.
News, Brillion.
Rock County Banner, Clinton.
Tribune, Clintonville.
Advance, Dartford.
Green Lake County Reporter, Dartford.
Chronicle, Dodgeville.
Leader, Eau Claire.
Blade, Elkhorn.

Independent, Elkhorn.
Journal, Grantsburg.
Der Landsmann, Green Bay.
Review, Green Bay.
News, Hammond.
Independent, Juneau.
News, Knapp.
Leader-Press, La Crosse.
Weekly Budget, Ladysmith.
Weekly Teller, Lancaster.
Star, Mauston.
Wisconsin Thalbote, Merrill.
Wisconsin Leader, Merrillan.
Der Landmann, Milwaukee.
Press, New London.
Enterprise, Oconomowoc.
La Crosse County Record, Onalaska.
Union, Prairie du Chien.
Free Press, Reedsburg.
Herald, Rib Lake.
Press, Ripon.
Polk County Press, St. Croix Falls.
Sheboygan County News, Sheboygan Falls.
Watchman, Shell Lake.
Door County Democrat, Sturgeon Bay.
Chronicle, Tigerton.
Journal, Tomah.
Tomahawk, Tomahawk.
Post, Waupaca.

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From Reale Scuola Superiore d'Agricoltura, Portici, Italy, Annali, ser. 2, vol. 3.

From Smithsonian Institution, Washington, D. C., report of National Museum for 1902.

From Dr. G. Stieger, Geschäftsführer, Berlin, Germany, Jahrbuch der Deutschen Landwirtschaftlichen Gesellschaft, 2 vol., and miscellaneous pamphlets.

From Dr. William Trelease, Director, St. Louis, Mo., 15th Annual Report of Missouri Botanical Garden.

From Wisconsin State Historical Society, Madison Wis., 463 vol. miscellaneous reports, and 1800 pamphlets.

From Mendota Book Co., Madison, Wis., two copies of Testing Milk and Its Products, by Farrington and Woll.

From A. F. Milton Druce, Sec'y, Oxford, England, Oxford Down Flock Book, vol. 16.

From John W. Groves, Sec'y, Chicago, Ill., American Shorthorn Herd Book, vol. 57 and 58.

From Frederick L. Houghton, Sec'y, Brattleboro, Vt., Holstein-Friesian Year Book, vol. 1-3, incl.

From S. Hoxie, Editor, Yorkville, N. Y., Holstein-Friesian Advanced Register, vol. 14 and 15.

From W. M. McFadden, Sec'y, Chicago, Ill., American Poland-China Record, vol. 33 and 34.

From Archibald MacNeilage, Sec'y, Glasgow, Scotland, Clydesdale Stud Book, vol. 26.

From John Parr, Sec'y, Ruddington, Nottingham, England, National Pig Breeders' Ass'n Herd Book, vol. 20.

From J. E. Rawlence, Sec'y, Salisbury, Wiltshire, England, Hampshire Down Flock Book, vol. 15.

From John Risdon, Jr., Sec'y, Wiveliscombe, Somerset, England, Davy's Devon Herd Book, vol. 14 and 27.

From Fred Smith, Sec'y, Woodbridge, Suffolk, England, Suffolk Stud Book, vol. 14.

FINANCIAL STATEMENT.

The Wisconsin Agricultural Experiment Station, in account with the United States appropriation.

1903-1904.	Dr.	Cr.
To receipt from treasurer of the United States as per appropriation for the year ending June 30th, 1904, under act of Congress, approved March 2d, 1887.	$15,000 00	
By salaries	....	$8,470 00
By labor	....	1,655 97
By publications	....	....
By postage and stationery	....	373 21
By freight and express	....	48 32
By heat, light and water	....	54 50
By chemical supplies	....	571 68
By seeds, plants, and sundry supplies	....	1,086 67
By fertilizers	....	20 15
By feeding stuffs	....	46 20
By library	....	542 06
By tools, implements and machinery	....	25 00
By furniture and fixtures	....	57 00
By scientific apparatus	....	497 96
By live stock	....	379 07
By traveling expenses	....	407 21
By contingent expenses	....	15 00
By building and repairs	....	750 00
	$15,000 00	$15,000 00

We, the undersigned duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Wisconsin Agricultural Experiment Station for the fiscal year ending June 30, 1904; that we have found the same well kept and classified as above, and that the receipts for the year from the treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file and have been by us examined and found correct.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress Approved March 2, 1887.

(Signed) WILLIAM F. VILAS,
L. S. HANKS,
Executive Committee.

ATTEST:
E. F. RILEY,
Custodian.

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NOTE.—Page numbers refer to pages of this report; subject matter in bulletins Nos. 110–115, published during the year, is also included in this index, reference to the same being made by giving the number of bulletin prefixed by B.

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Due.